



**RAMAPO  
COLLEGE**  
OF NEW JERSEY

## **LEARNING COMMONS**

**RCNJ Bid No. 2015-35-02C**

### **Construction Documents Specifications**

### **Volume 2**

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**BOHLIN CYWINSKI JACKSON**  
Project No. 16106A

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## **SECTION 02 01 87 - PROTECTION OF EXISTING UTILITIES**

### **PART 1 - GENERAL**

#### **1.1 SCOPE OF WORK**

- A. Identification and field mark out of all on-site utility lines to remain in operation during construction.
- B. Identification and field markout of all off-site utility lines within construction work areas.
- C. Submission of procedures to be used to ensure the safety of the utility.
- D. Conduct test pit excavation at all proposed utility crossings prior to construction.
- E. Repair of any damage during construction operations.
- F. Relocate utilities that are indicated as such.

#### **1.2 RELATED SECTIONS AND DOCUMENTS**

- A. Contract Drawings

#### **1.3 PROJECT RECORD DOCUMENTS**

- A. Accurately record actual locations of capped utilities and utility lines encountered during construction.
- B. Accurately record actual locations and elevations of existing utilities at proposed utility crossings prior to utility and storm sewer construction. Submit recorded data to Owner's Engineer for verification of proposed design.

#### **1.4 REGULATORY REQUIREMENTS**

- A. Contractor shall notify all affected utility companies, agencies, authorities, owners, etc. at least 48 hours prior to the commencement of work or as required by each agency and shall comply with their requirements.
- B. Contractor shall contact the "New Jersey One Call System", (800) 272-1000, service for an official utility mark out.

### **PART 2 - PRODUCTS**

NOT APPLICABLE

### **PART 3 - EXECUTION**

#### **3.1 IDENTIFICATION**

- A. Locate all existing utilities which are to remain in service and/or require relocating during construction as shown on the Contract Drawings.

#### **3.2 PROTECTION**

- A. Flag, barricade or suitably protect existing utilities during construction operations and equipment movement. Install shoring and bracing as required.

- B. Prevent interruption of existing utility service to occupied or used facilities, except when authorized in writing by authorities having jurisdiction.

### **3.3 LATERAL DISCONNECTION**

- A. Where a utility line is to be disconnected from portions to remain, the lateral pipes shall be cut and suitably plugged/capped in accordance with the Contract Drawings and applicable utility or agency requirements.

### **3.4 REPAIRS**

- A. Any damage to existing, operational utilities by the Contractor or his subcontractors during the on-going construction operation shall be immediately repaired to operational standards at the Contractor's expense. If the repairs are not immediately addressed by the Contractor, the utility owner and/or the Owner shall have the right to contract for the repair at the Contractor's expense.

### **3.5 RELOCATIONS**

- A. Where utility lines are designated to be relocated, construct new utilities as shown and in accordance with these specifications and then remove former service to minimize disruption to the best extent practical. This operation shall be coordinated with the appropriate Authorities, as necessary.

**END OF SECTION 02 01 87**

## **SECTION 02 20 00 – TEMPORARY TREE AND PLANT PROTECTION**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes general protection and pruning of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction.
- B. Related Sections:
  - 1. Division 01 Section "Temporary Facilities and Controls" for temporary site fencing.
  - 2. Division 31 Section "Site Clearing" for removing existing trees and shrubs.

#### **1.3 DEFINITIONS**

- A. Caliper: Diameter of a trunk measured by a diameter tape or the average of the smallest and largest diameters at 6 inches above the ground for trees up to, and including, 4-inch size; and 12 inches above the ground for trees larger than 4-inch size.
- B. Tree-Protection Zone: Fence encompassed areas of individual trees or groups of trees to be protected during construction, and indicated on Drawings
- C. Plant-Protection Zone: Fence encompassed areas of individual trees, groups of trees, seeding, shrubs, or other vegetation to be protected during construction, and indicated on Drawings.
- D. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Samples for Verification: For each type of the following:
  - 1. Organic Mulch: 1-quart volume of organic mulch; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.
  - 2. Protection-Zone Signage: Full-size Samples of each size and text, ready for installation.
- C. Tree Pruning Schedule: Written schedule detailing scope and extent of pruning for trees 4" caliper or greater to remain on site. Schedule should include the following information:
  - 1. Species and size of tree.
  - 2. Location on site plan. Include unique identifier for each.
  - 3. Reason for pruning or reason for inaction.
  - 4. Description of pruning to be performed.
  - 5. Description of maintenance following pruning.
- D. Qualification Data: For qualified arborist and tree service firm.

- E. Certification: From arborist, certifying that trees indicated to remain have been protected during construction according to recognized standards and that trees were promptly and properly treated and repaired when damaged.
- F. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.
- G. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions that might be misconstrued as damage caused by construction activities.
  - 1. Use sufficiently detailed photographs.
  - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

## **1.5 QUALITY ASSURANCE**

- A. Arborist Qualifications: Certified Arborist as certified by ISA
- B. Tree Service Firm Qualifications: An experienced tree service firm that has successfully completed temporary tree and plant protection work similar to that required for this Project and that will assign an experienced, qualified arborist to Project site during execution of the Work.
- C. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:
    - a. Construction schedule. Verify availability of materials, personnel, and equipment needed to make progress and avoid delays.
    - b. Enforcing requirements for protection zones.
    - c. Arborist's responsibilities.
    - d. Field quality control.

## **1.6 PROJECT CONDITIONS**

- A. The following practices are prohibited within protection zones:
  - 1. Storage of construction materials, debris, or excavated material.
  - 2. Parking vehicles or equipment.
  - 3. Foot traffic.
  - 4. Erection of sheds or structures.
  - 5. Impoundment of water.
  - 6. Excavation or other digging unless otherwise indicated.
  - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- B. Do not direct vehicle or equipment exhaust toward protection zones.
- C. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones and organic mulch.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Topsoil: Imported or manufactured topsoil complying with topsoil definition in 329200 Turf and Grasses.
- B. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:
  - 1. Type: Wood and bark chips.
  - 2. Size Range: 3 inches maximum, 1/2 inch minimum.
  - 3. Color: Natural.
- C. Protection-Zone Fencing: Fencing fixed in position and meeting the following requirements. Previously used materials may be used when approved by Landscape Architect.
  - 1. Tree Protection-Zone Fencing: Galvanized-steel fencing fabricated from minimum 2-inch opening, 0.148-inch-diameter wire chain-link fabric; with pipe posts, minimum 2-3/8-inch-OD line posts, and 2-7/8-inch-OD corner and pull posts and 0.177-inch-diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.
    - a. Height: 5 feet
  - 2. Plant Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 1inch (25-mm) by 2-inch maximum opening in pattern and weighing a minimum of 0.4 lb/ft.; remaining flexible from minus 60 to plus 200 deg F; inert to most chemicals and acids; minimum tensile yield strength of 2000 psi and ultimate tensile strength of 2680 psi; secured firmly with steel rebar ties at the top, middle and bottom; and supported by 2"x2"x6' hardwood stakes spaced not more than 8 feet apart.
    - a. Height: 4 feet.
    - b. Color: High-visibility, International Orange, nonfading.
  - 3. Gates: Double swing access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones; leaf width 36 inches
- D. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes prepunched and reinforced; legibly printed with nonfading lettering and as follows:
  - 1. Text: 1) NO VEHICLE MOVEMENT 2) NO STORAGE OF BUILDING MATERIALS 3) NO WASHING OF EQUIPMENT 4) CONTACT NAME & NUMBER FOR INQUIRIES AS FOLLOWS: DIRTWORKS LANDSCAPE ARCHITECTURE; 212-529-2263
  - 2. Lettering: 3-inch-high minimum, black characters on white background.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- B. For the record, prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

### **3.2 PREPARATION**

- A. Locate and clearly identify trees, shrubs, and other vegetation to remain. Tie a 1-inch blue-vinyl tape around each tree trunk at 54 inches above the ground for each tree to be protected.
- B. Locate and clearly identify trees, shrubs, and other vegetation to be transplanted. Tie a 1-inch pink-vinyl tape around each tree trunk at 54 inches above the ground for each tree to be transplanted.
- C. Protect tree root systems from damage caused by runoff or spillage of noxious materials while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.
- D. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated.
  - 1. Apply 4-inch average thickness of organic mulch. Do not place mulch within 6 inches of tree trunks.

### **3.3 TREE- AND PLANT-PROTECTION ZONES**

- A. Tree Protection-Zone Fencing: Install tree protection-zone fencing where indicated on the drawings along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people and vehicles from easily entering protected area except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.
  - 1. Chain-Link Fencing: Install to comply with ASTM F 567 and with manufacturer's written instructions.
  - 2. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Landscape Architect.
  - 3. Access Gates: Install where indicated; adjust to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Plant Protection Zone Fencing: Install plant protection-zone fencing where indicated on the drawings along edges of protection zones after planting and seed application has occurred in a manner that will prevent people and vehicles from easily entering protected area. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.
  - 1. Plastic Fencing: Install to comply with manufacturer's written instructions.
  - 2. Posts: Set or drive posts into ground minimum 2' without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Landscape Architect.
- C. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Landscape Architect. Install one sign spaced approximately every 35 feet on protection-zone fencing, but no fewer than four signs with each facing a different direction.
- D. Maintain protection zones free of weeds and trash.

- E. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Landscape Architect.
- F. Maintain protection-zone fencing and signage in good condition as acceptable to Landscape Architect and remove when construction operations are complete and equipment has been removed from the site.
  - 1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
  - 2. Temporary access is permitted subject to preapproval in writing by arborist if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

### **3.4 EXCAVATION**

- A. General: Excavate at edge of protection zones and for trenches indicated within protection zones according to requirements in Division 31 Section "Earth Moving."
- B. Trenching near Trees: Where utility trenches are required within protection zones, hand excavate under or around tree roots or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities. Cut roots as required for root pruning.
- C. Redirect roots in backfill areas where possible. If encountering large, main lateral roots, expose roots beyond excavation limits as required to bend and redirect them without breaking. If encountered immediately adjacent to location of new construction and redirection is not practical, cut roots approximately 3 inches back from new construction and as required for root pruning.
- D. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

### **3.5 ROOT PRUNING**

- A. Prune roots that are affected by temporary and permanent construction. Prune roots under the supervision of a certified arborist
  - 1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
  - 2. Cut Ends: Do not paint cut root ends
  - 3. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
  - 4. Cover exposed roots with burlap and water regularly.
  - 5. Backfill as soon as possible according to requirements in Division 31 Section "Earth Moving."
- B. Root Pruning at Edge of Protection Zone: Prune roots flush with the edge of the disturbance, by cleanly cutting all roots to the depth of the required excavation.
- C. Root Pruning within Protection Zone: Clear and excavate by hand to the depth of the required excavation to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.



### **3.6 CROWN PRUNING**

- A. Prune branches that are affected by temporary and permanent construction. Prune branches under the supervision of a certified arborist
  - 1. 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.
  - 2. Pruning Standards: Prune trees according to ANSI A300 (Part 1).
    - a. Type of Pruning: Cleaning, Thinning, Raising and Reduction.
  - 3. Cut branches with sharp pruning instruments; do not break or chop.
  - 4. Do not apply pruning paint to wounds.
- B. Chip removed branches and stockpile in areas approved by Landscape Architect.

### **3.7 REGRADING**

- A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.
  - 1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.
- C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.
- D. Minor Fill within Protection Zone: Where existing grade is 2 inches or less below elevation of finish grade, fill with topsoil. Place topsoil in a single uncompacted layer and hand grade to required finish elevations.

### **3.8 FIELD QUALITY CONTROL**

- A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

### **3.9 REPAIR AND REPLACEMENT**

- A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Landscape Architect.
  - 1. Submit details of proposed root cutting and tree and shrub repairs.
  - 2. Have arborist perform the root cutting, branch pruning, and damage repair of trees and shrubs.
  - 3. Treat damaged trunks, limbs, and roots according to arborist's written instructions.
  - 4. Perform repairs within 24 hours.
  - 5. Replace vegetation that cannot be repaired and restored to full-growth status, as determined by Landscape Architect.
- B. Trees: Remove and replace trees indicated to remain that are more than 50 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during

construction operations that Landscape Architect determines are incapable of restoring to normal growth pattern.

1. Provide two new trees of 6-inch caliper size for each tree being replaced that measures more than 6 inches in caliper size.

a. Species: to be determined by Landscape Architect

2. Plant and maintain new trees as specified in Division 32 Section "Plants."

C. Soil Aeration: Where directed by Landscape Architect, aerate surface soil compacted during construction. Aerate 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.

### **3.10 DISPOSAL OF SURPLUS AND WASTE MATERIALS**

A. Disposal: Remove excess excavated material, displaced trees, trash and debris, and legally dispose of them off Owner's property.

**END OF SECTION 02 20 00**

## **SECTION 02 41 16 - STRUCTURE DEMOLITION**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Demolition and removal of buildings.
  - 2. Abandoning in-place and/or Removing below-grade construction.
- B. Related Requirements:
  - 1. Division 01 Section "Summary of Work" for use of the premises and phasing requirements.
  - 2. Division 02 Section "Selective Demolition" for partial demolition of buildings, structures, and site improvements.
  - 3. Division 31 Section "Site Preparation" for site clearing and removal of above- and below-grade site improvements not part of building demolition.

#### **1.3 DEFINITIONS**

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse. Include fasteners or brackets needed for reattachment elsewhere.

#### **1.4 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.

#### **1.5 PREINSTALLATION MEETINGS**

- A. Predemolition Conference: Conduct conference at Project site.
  - 1. Inspect and discuss condition of construction to be demolished.
  - 2. Review structural load limitations of existing structures.
  - 3. Review and finalize building demolition schedule and verify availability of demolition personnel, equipment, and facilities needed to make progress and avoid delays.
  - 4. Review and finalize protection requirements.
  - 5. Review procedures for **noise control and dust control**.
  - 6. Review procedures for protection of adjacent buildings.
  - 7. Review items to be salvaged and returned to Owner.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For refrigerant recovery technician.
- B. Engineering Survey: Submit engineering survey of condition of building.
- C. Proposed Protection Measures: Submit 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 including means of egress from those buildings.
- D. 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.
- E. Predemolition Photographs or Video: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by demolition operations.

## 1.7 CLOSEOUT SUBMITTALS

- A. Inventory: Submit a list of items that have been removed and salvaged.

## 1.8 QUALITY ASSURANCE

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

## 1.9 FIELD 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. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- D. Hazardous Materials: Present in buildings and structures to be demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
  - 1. Hazardous material remediation is specified elsewhere in the Contract Documents.
  - 2. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
  - 3. Owner will provide material safety data sheets for materials that are known to be present in buildings and structures to be demolished because of building operations or processes performed there.
- E. On-site storage or sale of removed items or materials is not permitted.

## 1.10 COORDINATION

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

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ASSE A10.6 and NFPA 241.

### 2.2 SOIL MATERIALS

- A. Satisfactory Soils: Comply with requirements in Division 31 Sections.

## 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 or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. **Engage a professional engineer to 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.
- D. Verify that hazardous materials have been remediated before proceeding with building demolition operations.
- E. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

### 3.2 PREPARATION

- A. 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 Owner.
  4. Transport items to storage area designated by Owner.
  5. Protect items from damage during transport and storage.

### 3.3 PROTECTION

- A. Existing Facilities: Protect adjacent walkways, loading docks, building entries, and other building facilities during demolition operations. Maintain exits from existing buildings.
- B. 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.

- C. Existing Utilities to Remain: See Division 02 Section "Protection of Existing Utilities to Remain."
- D. Temporary Protection: Erect temporary protection, such as walks, fences, railings, canopies, and covered passageways, where required by authorities having jurisdiction and as indicated.
  - 1. Protect adjacent buildings and facilities from damage due to demolition activities.
  - 2. Protect existing site improvements, appurtenances, and landscaping to remain.
  - 3. Erect a plainly visible fence around drip line of individual trees or around perimeter drip line of groups of trees to remain.
  - 4. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  - 5. Provide protection to ensure safe passage of people around building demolition area and to and from occupied portions of adjacent buildings and structures.
  - 6. Protect walls, windows, roofs, and other adjacent exterior construction that are to remain and that are exposed to building demolition operations.
  - 7. Erect and maintain dustproof partitions and temporary enclosures to limit dust, noise, and dirt migration to occupied portions of adjacent buildings.
- E. 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 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 for period of time required by owner 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. 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 Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed trafficways 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.
- C. 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 removed and salvaged are indicated on Drawings.
- D. Below-Grade Construction: Demolish foundation walls and other below-grade construction as noted on plans.
  - 1. Remove below-grade construction, including basements, foundation walls, and footings, to depths indicated.

### **3.6 SITE RESTORATION**

- A. Below-Grade Areas: Rough grade below-grade areas ready for further excavation or new construction.
- B. Below-Grade Areas: Completely fill below-grade areas and voids resulting from building demolition operations with satisfactory soil materials according to backfill requirements in Division 31 Sections.
- C. 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 and recycle or dispose of them according to" Division 01 Section "Waste Management."
  - 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.
  - 1. Clean roadways of debris caused by debris transport.

**END OF SECTION 02 41 16**

## **SECTION 02 41 19 - SELECTIVE DEMOLITION**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Demolition and removal of selected portions of building.
  - 2. Demolition and removal of selected site elements.
  - 3. Salvage of existing items to be reused or recycled, including:
    - a. Slate panel exterior cladding of existing building, as described in Division 4 Section "Exterior Stone Cladding."
    - b. Building directory in A wing.
    - c. Exterior freestanding stainless steel book drop unit.
- B. Related Requirements:
  - 1. Division 1 Section "Summary of Work" for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
  - 2. Division 1 Section "Waste Management" for recycling and disposal of demolition waste.
  - 3. Division 1 Section "Temporary Tree and Plant Protection" for temporary protection of existing trees and plants that are affected by selective demolition.
  - 4. Division 2 Section "Structure Demolition" for demolition of structural elements such as steel, concrete and masonry backup walls.
  - 5. Division 2 Section "Protection of Existing Utilities."
  - 6. Division 4 Section "Exterior Stone Cladding" for removal, cleaning, cutting and reinstallation of slate panels.

#### **1.3 DEFINITIONS**

- A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.
- B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and store.
- C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
- D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
- E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

#### **1.4 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.

## **1.5 PREINSTALLATION MEETINGS**

- A. Predemolition Conference: Conduct conference at Project site.
  1. Inspect and discuss condition of construction to be selectively demolished.
  2. Review structural load limitations of existing structure.
  3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
  4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
  5. Review areas where existing construction is to remain and requires protection.

## **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For refrigerant recovery technician.
- B. Proposed Protection Measures: Submit 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.
- C. Schedule of Selective Demolition Activities: Indicate the following:
  1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure campus activities surrounding building remain uninterrupted.
  2. Interruption of utility services. Indicate how long utility services will be interrupted.
  3. Coordination for shutoff, capping, and continuation of utility services.
  4. Use of elevator and stairs.
- D. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations.
- E. 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.
- F. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

## **1.7 CLOSEOUT SUBMITTALS**

- A. Inventory: Submit a list of items that have been removed and salvaged.

## **1.8 QUALITY ASSURANCE**

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

## **1.9 FIELD CONDITIONS**

- A. Owner will occupy buildings immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

1. All loose items will be removed and disposed of by contractor. Owner will salvage all items they want prior to demo mobilization. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- C. Hazardous Materials: Present in buildings and structures to be selectively demolished. A report on the presence of hazardous materials is on file for review and use. Examine report to become aware of locations where hazardous materials are present.
  1. Do not disturb hazardous materials or items suspected of containing hazardous materials except under procedures specified elsewhere in the Contract Documents.
  2. Owner will provide material safety data sheets for suspected hazardous materials that are known to be present in buildings and structures to be selectively demolished because of building operations or processes performed there.
- D. Storage or sale of removed items or materials on-site is not permitted.
- E. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.
  1. Maintain fire-protection facilities in service during selective demolition operations.

#### **1.10 WARRANTY**

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding. Existing warranties include the following:
  1. PVC roof to remain.
- B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

#### **1.11 COORDINATION**

- A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

### **PART 2 - PRODUCTS**

#### **2.1 PERFORMANCE REQUIREMENTS**

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ASSE A10.6 and NFPA 241.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.
- B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.
- C. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

- D. Survey of Existing Conditions: See Division 4 Section “Exterior Stone Cladding” for survey of existing slate panel cladding prior to removal.

### **3.2 PREPARATION**

- A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

### **3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS**

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
  - 1. Arrange to shut off utilities with utility companies.
  - 2. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
  - 3. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.
    - a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    - b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
    - c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    - d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    - e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    - f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    - g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

### **3.4 PROTECTION**

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
  - 1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
  - 2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
  - 3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
  - 1. Strengthen or add new supports when required during progress of selective demolition.
- C. Remove temporary barricades and protections where hazards no longer exist.

### 3.5 SELECTIVE DEMOLITION, GENERAL

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
  2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
  3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
  4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
  5. Maintain fire watch during and for period of time required by owner after flame-cutting operations.
  6. Maintain adequate ventilation when using cutting torches.
  7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
  8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
  9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
  10. Dispose of demolished items and materials promptly. Comply with requirements in Division 1 Section "Waste Management."
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Removed and Salvaged Items:
1. Clean salvaged items.
  2. Pack or crate items after cleaning. Identify contents of containers.
  3. Store items in a secure area until delivery to Owner.
  4. Transport items to Owner's storage area designated by Owner. Provide 72 hours' notice prior to scheduled relocation.
  5. Protect items from damage during transport and storage.
- D. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
  2. Pack or crate items after cleaning and repairing. Identify contents of containers.
  3. Protect items from damage during transport and storage.
  4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- E. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

### **3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS**

- A. Masonry: Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw, and then remove masonry between saw cuts.
- B. Roofing: Remove no more existing roofing than what can be covered in one day by new roofing and so that building interior remains watertight and weathertight. See Division 7 Section "PVC Roofing" for new roofing requirements.
  - 1. Remove existing roof membrane, flashings, copings, and roof accessories only as shown in the Drawings.

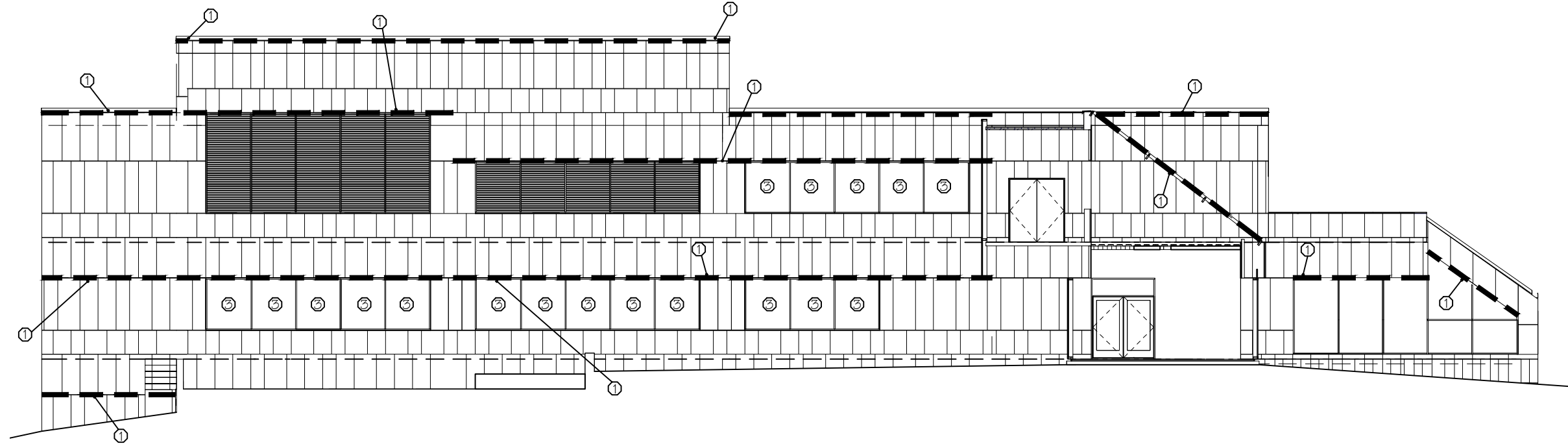
### **3.7 DISPOSAL OF DEMOLISHED MATERIALS**

- A. Remove demolition waste materials from Project site and recycle or dispose of them according to Division 1 Section "Waste Management."
  - 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.
  - 3. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
- B. Burning: Do not burn demolished materials.

### **3.8 CLEANING**

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

**END OF SECTION 02 41 19**



- LEGEND -

--- EXTENT OF EXISTING STONE, MISCELLANEOUS METALS, STEEL SUPPORTS TO BE DEMOLISHED WITH ASBESTOS COATING

1 NORTH ELEVATION  
HA.1 SCALE: NTS

- KEYED ABATEMENT NOTES -

- ① REMOVE AND DISPOSE OF OF ASBESTOS-CONTAINING BLACK TAR COATING WITH TAR PAPER ON STRUCTURAL STEEL (STEEL SUPPORTS).
- ② REMOVE AND DISPOSE OF APPROXIMATELY 30 LF OF BLACK/WHITE SEALANT AT INTERFACE OF AWNING AND SLATE PANELS.
- ③ REMOVE AND DISPOSE OF 82 WINDOW UNITS (APPROX. 1640 LF) WITH ASBESTOS-CONTAINING BLACK EXTERIOR GLAZING.

- GENERAL NOTES -

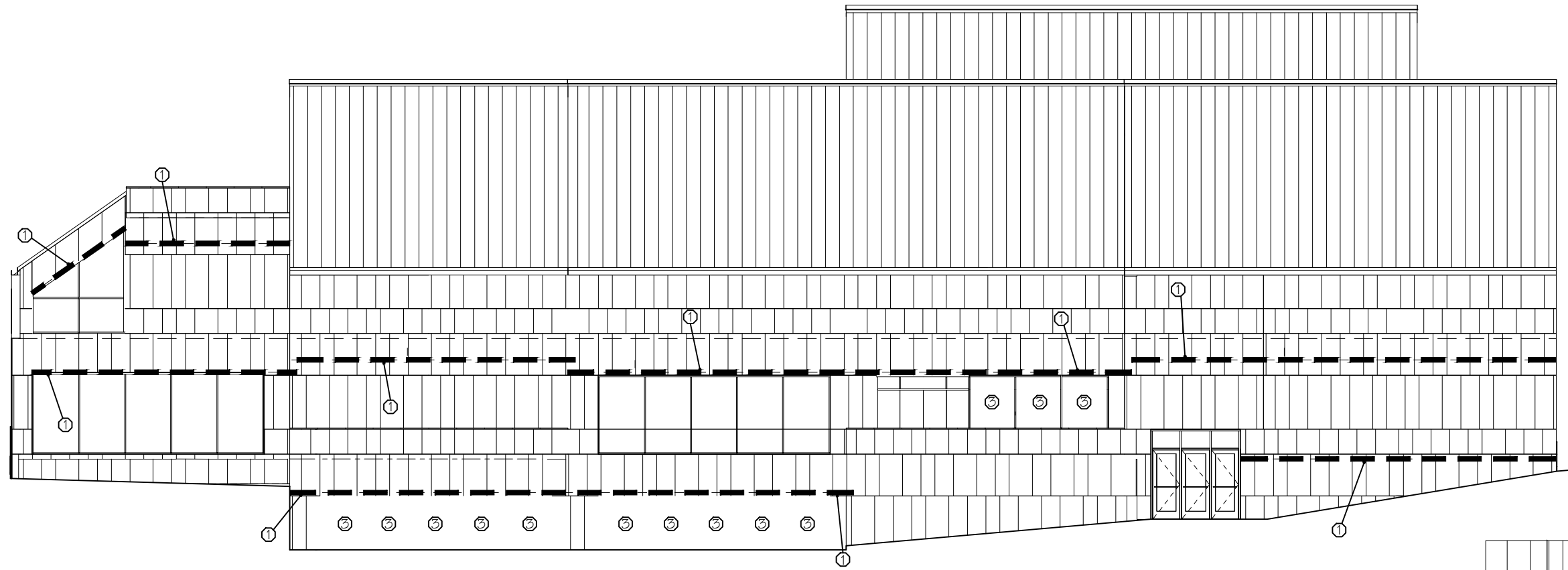
- 1. COORDINATE ALL ABATEMENT WORK, A MINIMUM OF 10-BUSINESS DAYS PRIOR TO MOBILIZATION, WITH THE PROJECT'S ENVIRONMENTAL CONSULTANT.
- 2. CONTRACTOR TO INSTALL A REMOTE THREE (3) STAGE DECONTAMINATION UNIT, AS SPECIFIED. LOCATION OF DECONTAMINATION UNIT SHALL BE COORDINATED WITH THE OWNER AND BE IN CLOSE PROXIMITY TO THE ABATEMENT WORK AREA(S).
- 3. ALL SPOT REMOVAL ABATEMENT OF BLACK TAR COATING WITH TAR PAPER ON STRUCTURAL STEEL SHALL BE COMPLETE WITHIN A NEGATIVE PRESSURE ENCLOSURE.
- 4. CONTRACTOR SHALL INSTALL AND UTILIZE FIXED SCAFFOLDING OR A MAN LIFT TO FACILITATE REMOVAL OF ASBESTOS-CONTAINING MATERIALS. COMPLY WITH ALL APPLICABLE OSHA FALL PROTECTION REQUIREMENTS.
- 5. DO NOT CONDUCT WORK ON THE EXTERIOR IF WIND SPEEDS ARE GREATER THAN TWENTY (20) MILES PER HOUR. WORK MUST STOP AND CLEAN UP MUST OCCUR BEFORE RAIN BEGINS.
- 6. ALL EXISTING STONE SUPPORT LINES SHOWN ON ELEVATIONS ARE APPROXIMATE AND HAVE BEEN BASED ON THE ORIGINAL DRAWINGS PREPARED BY MAHONY & ZVOSEC KENNETH DEMAY, DATED 3/21/1979 AND PRESENTED TO USA ENVIRONMENTAL MANAGEMENT, INC., BY BOHLIN CYWINSKI JACKSON IN 50% CD DATED 9/7/2018. ALL LOCATIONS ARE TO BE VERIFIED IN THE FIELD.

Rev:	Date:	By:

USAEMI Project Number: <b>17-020310-02</b>	Scale: AS NOTED	Checked By: W.W.J.
Date: 03-13-2019	Drawn By: W.K.M.	Project Number: <b>2015-35-02C</b>
Wayne K. Martin, Project Designer Certificate No. NAE1153078		
USA Environmental Management, Inc. 344 West State Street Trenton, NJ 08618 609.656.8101 Environmental, Engineering & Construction		
Ramapo College of New Jersey 505 Ramapo Valley Road Mahwah, New Jersey 07430 Hazardous Materials Abatement Plans for Library & Learning Commons		
Drawing Title: North Elevation Abatement Plan		
Drawing No. <b>HA.1</b>		
Sheet: 1 of 4		

- LEGEND -

--- EXTENT OF EXISTING STONE, MISCELLANEOUS METALS, STEEL SUPPORTS TO BE DEMOLISHED WITH ASBESTOS COATING



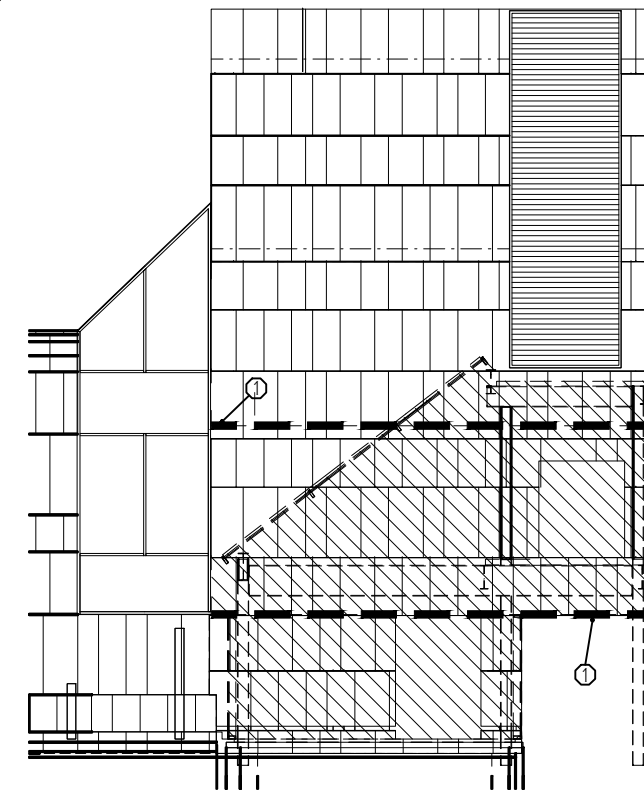
1 SOUTH ELEVATION  
HA.2 SCALE: N.T.S.

- KEYED ABATEMENT NOTES -

- 1 REMOVE AND DISPOSE OF OF ASBESTOS-CONTAINING BLACK TAR COATING WITH TAR PAPER ON STRUCTURAL STEEL (STEEL SUPPORTS).
- 2 REMOVE AND DISPOSE OF APPROXIMATELY 30 LF OF BLACK/WHITE SEALANT AT INTERFACE OF AWNING AND SLATE PANELS.
- 3 REMOVE AND DISPOSE OF 82 WINDOW UNITS (APPROX. 1640 LF) WITH ASBESTOS-CONTAINING BLACK EXTERIOR GLAZING.

- GENERAL NOTES -

- 1. COORDINATE ALL ABATEMENT WORK, A MINIMUM OF 10-BUSINESS DAYS PRIOR TO MOBILIZATION, WITH THE PROJECT'S ENVIRONMENTAL CONSULTANT.
- 2. CONTRACTOR TO INSTALL A REMOTE THREE (3) STAGE DECONTAMINATION UNIT, AS SPECIFIED. LOCATION OF DECONTAMINATION UNIT SHALL BE COORDINATED WITH THE OWNER AND BE IN CLOSE PROXIMITY TO THE ABATEMENT WORK AREA(S).
- 3. ALL SPOT REMOVAL ABATEMENT OF BLACK TAR COATING WITH TAR PAPER ON STRUCTURAL STEEL SHALL BE COMPLETE WITHIN A NEGATIVE PRESSURE ENCLOSURE.
- 4. CONTRACTOR SHALL INSTALL AND UTILIZE FIXED SCAFFOLDING OR A MAN LIFT TO FACILITATE REMOVAL OF ASBESTOS-CONTAINING MATERIALS. COMPLY WITH ALL APPLICABLE OSHA FALL PROTECTION REQUIREMENTS.
- 5. DO NOT CONDUCT WORK ON THE EXTERIOR IF WIND SPEEDS ARE GREATER THAN TWENTY (20) MILES PER HOUR. WORK MUST STOP AND CLEAN UP MUST OCCUR BEFORE RAIN BEGINS.
- 6. ALL EXISTING STONE SUPPORT LINES SHOWN ON ELEVATIONS ARE APPROXIMATE AND HAVE BEEN BASED ON THE ORIGINAL DRAWINGS PREPARED BY MAHONY & ZVOSEC KENNETH DEMAY, DATED 3/21/1979 AND PRESENTED TO USA ENVIRONMENTAL MANAGEMENT, INC., BY BOHLIN CYWINSKI JACKSON IN 50% CD DATED 9/7/2018. ALL LOCATIONS ARE TO BE VERIFIED IN THE FIELD.



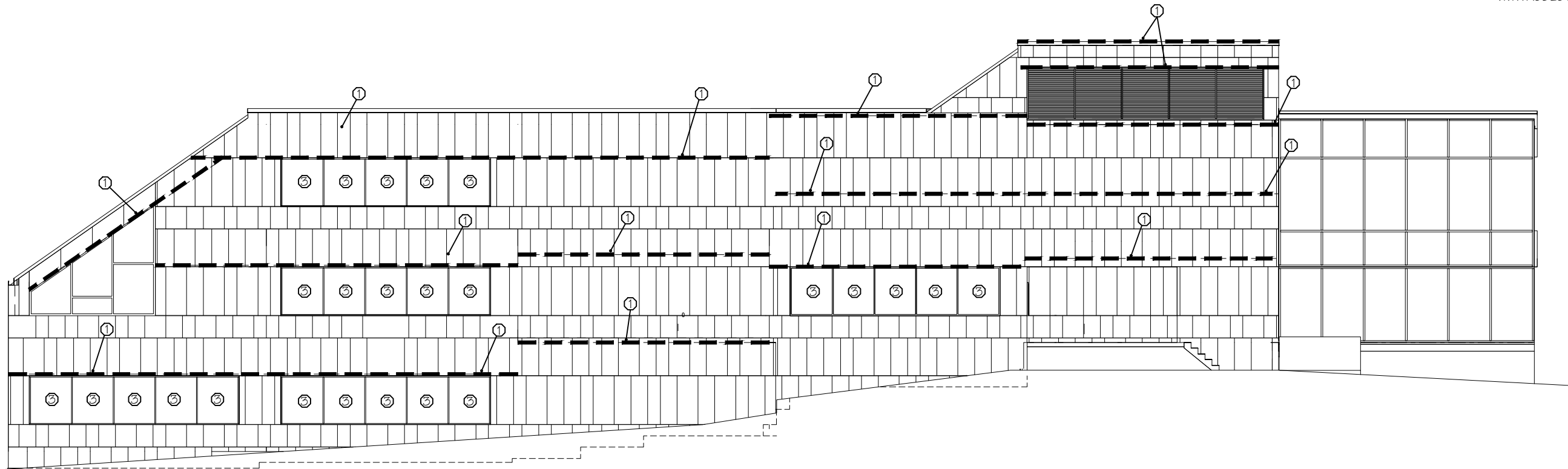
2 SOUTH ELEVATION  
HA.2 SCALE: N.T.S.

Rev:	Date:	By:

USAEMI Project Number: 17-020310-02	Scale: AS NOTED	Date: 03-13-2019	Checked by: W.W.J.	Project Number: 2015-35-02C
Wayne K. Martin, Project Designer Certificate No. NAE1153078				
USA Environmental Management, Inc. 344 West State Street Trenton, NJ 08618 609.656.8101 Environmental, Engineering & Construction				
Ramapo College of New Jersey 505 Ramapo Valley Road Mahwah, New Jersey 07430 Hazardous Materials Abatement Plans for Library & Learning Commons				
Drawing Title: South Elevation Abatement Plan				
Drawing No. HA.2				
Sheet: 2 of 4				

- LEGEND -

--- EXTENT OF EXISTING STONE, MISCELLANEOUS METALS, STEEL SUPPORTS TO BE DEMOLISHED WITH ASBESTOS COATING



1 EAST ELEVATION  
HA.3 SCALE: N.T.S.

- KEYED ABATEMENT NOTES -

- ① REMOVE AND DISPOSE OF OF ASBESTOS-CONTAINING BLACK TAR COATING WITH TAR PAPER ON STRUCTURAL STEEL (STEEL SUPPORTS).
- ② REMOVE AND DISPOSE OF APPROXIMATELY 30 LF OF BLACK/WHITE SEALANT AT INTERFACE OF AWNING AND SLATE PANELS.
- ③ REMOVE AND DISPOSE OF 82 WINDOW UNITS (APPROX. 1640 LF) WITH ASBESTOS-CONTAINING BLACK EXTERIOR GLAZING.

- GENERAL NOTES -

- 1. COORDINATE ALL ABATEMENT WORK, A MINIMUM OF 10-BUSINESS DAYS PRIOR TO MOBILIZATION, WITH THE PROJECT'S ENVIRONMENTAL CONSULTANT.
- 2. CONTRACTOR TO INSTALL A REMOTE THREE (3) STAGE DECONTAMINATION UNIT, AS SPECIFIED. LOCATION OF DECONTAMINATION UNIT SHALL BE COORDINATED WITH THE OWNER AND BE IN CLOSE PROXIMITY TO THE ABATEMENT WORK AREA(S).
- 3. ALL SPOT REMOVAL ABATEMENT OF BLACK TAR COATING WITH TAR PAPER ON STRUCTURAL STEEL SHALL BE COMPLETE WITHIN A NEGATIVE PRESSURE ENCLOSURE.
- 4. CONTRACTOR SHALL INSTALL AND UTILIZE FIXED SCAFFOLDING OR A MAN LIFT TO FACILITATE REMOVAL OF ASBESTOS-CONTAINING MATERIALS. COMPLY WITH ALL APPLICABLE OSHA FALL PROTECTION REQUIREMENTS.
- 5. DO NOT CONDUCT WORK ON THE EXTERIOR IF WIND SPEEDS ARE GREATER THAN TWENTY (20) MILES PER HOUR. WORK MUST STOP AND CLEAN UP MUST OCCUR BEFORE RAIN BEGINS.
- 6. ALL EXISTING STONE SUPPORT LINES SHOWN ON ELEVATIONS ARE APPROXIMATE AND HAVE BEEN BASED ON THE ORIGINAL DRAWINGS PREPARED BY MAHONY & ZVOSEC KENNETH DEMAY, DATED 3/21/1979 AND PRESENTED TO USA ENVIRONMENTAL MANAGEMENT, INC., BY BOHLIN CYWINSKI JACKSON IN 50% CD DATED 9/7/2018. ALL LOCATIONS ARE TO BE VERIFIED IN THE FIELD.

Rev:	Date:	By:

USAEMI  
Project Number:  
17-020310-02  
RCNJ  
Project Number:  
2015-35-02C

Scale:  
AS NOTED  
Checked By:  
W.W.J.

Date:  
03-13-2019  
Drawn By:  
W.K.M.

Wayne K. Martin, Project Designer  
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609.656.8101  
Environmental, Engineering & Construction

Ramapo College of New Jersey  
505 Ramapo Valley Road  
Mahwah, New Jersey 07430  
Hazardous Materials Abatement Plans  
for  
Library & Learning Commons

Drawing Title:  
East  
Elevation  
Abatement  
Plan

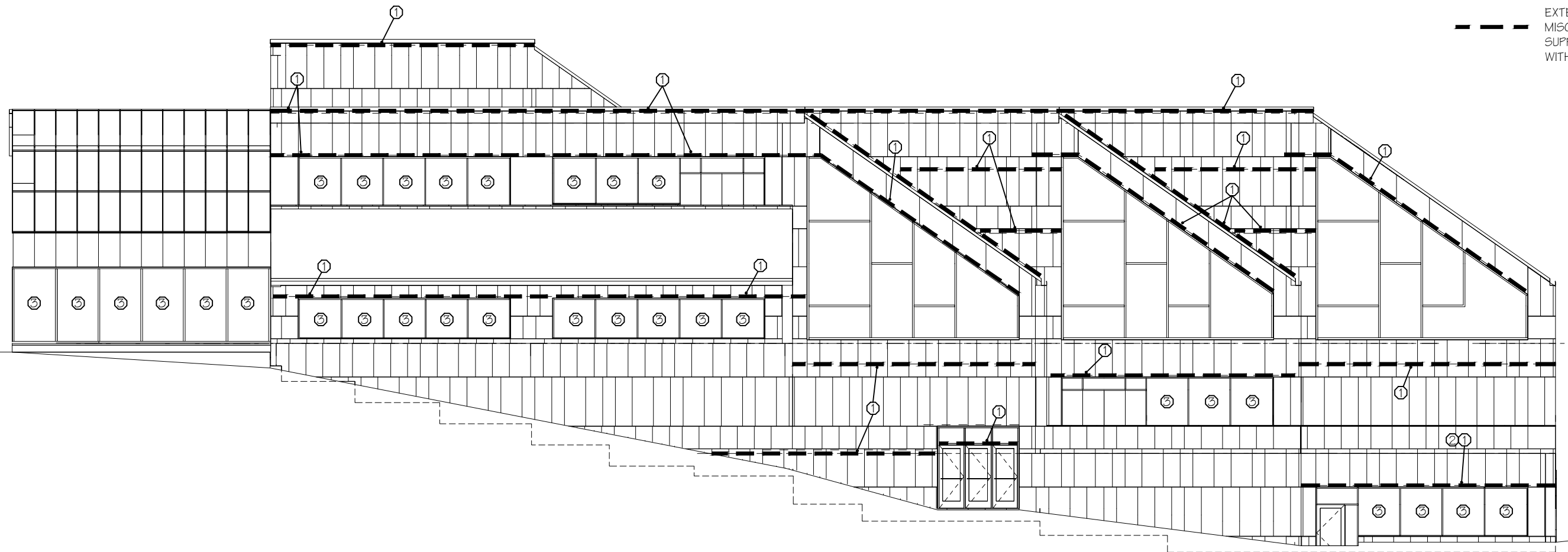
Drawing No.

HA.3



- LEGEND -

--- EXTENT OF EXISTING STONE, MISCELLANEOUS METALS, STEEL SUPPORTS TO BE DEMOLISHED WITH ASBESTOS COATING



1 WEST ELEVATION  
HA.4 SCALE: N.T.S.

- KEYED ABATEMENT NOTES -

- ① REMOVE AND DISPOSE OF OF ASBESTOS-CONTAINING BLACK TAR COATING WITH TAR PAPER ON STRUCTURAL STEEL (STEEL SUPPORTS).
- ② REMOVE AND DISPOSE OF APPROXIMATELY 30 LF OF BLACK/WHITE SEALANT AT INTERFACE OF AWNING AND SLATE PANELS.
- ③ REMOVE AND DISPOSE OF 82 WINDOW UNITS (APPROX. 1640 LF) WITH ASBESTOS-CONTAINING BLACK EXTERIOR GLAZING.

- GENERAL NOTES -

- 1. COORDINATE ALL ABATEMENT WORK, A MINIMUM OF 10-BUSINESS DAYS PRIOR TO MOBILIZATION, WITH THE PROJECT'S ENVIRONMENTAL CONSULTANT.
- 2. CONTRACTOR TO INSTALL A REMOTE THREE (3) STAGE DECONTAMINATION UNIT, AS SPECIFIED. LOCATION OF DECONTAMINATION UNIT SHALL BE COORDINATED WITH THE OWNER AND BE IN CLOSE PROXIMITY TO THE ABATEMENT WORK AREA(S).
- 3. ALL SPOT REMOVAL ABATEMENT OF BLACK TAR COATING WITH TAR PAPER ON STRUCTURAL STEEL SHALL BE COMPLETE WITHIN A NEGATIVE PRESSURE ENCLOSURE.
- 4. CONTRACTOR SHALL INSTALL AND UTILIZE FIXED SCAFFOLDING OR A MAN LIFT TO FACILITATE REMOVAL OF ASBESTOS-CONTAINING MATERIALS. COMPLY WITH ALL APPLICABLE OSHA FALL PROTECTION REQUIREMENTS.
- 5. DO NOT CONDUCT WORK ON THE EXTERIOR IF WIND SPEEDS ARE GREATER THAN TWENTY (20) MILES PER HOUR. WORK MUST STOP AND CLEAN UP MUST OCCUR BEFORE RAIN BEGINS.
- 6. ALL EXISTING STONE SUPPORT LINES SHOWN ON ELEVATIONS ARE APPROXIMATE AND HAVE BEEN BASED ON THE ORIGINAL DRAWINGS PREPARED BY MAHONY & ZVOSEC KENNETH DEMAY, DATED 3/21/1979 AND PRESENTED TO USA ENVIRONMENTAL MANAGEMENT, INC., BY BOHLIN CYWINSKI JACKSON IN 50% CD DATED 9/7/2018. ALL LOCATIONS ARE TO BE VERIFIED IN THE FIELD.

USAEMI  
Project Number:  
17-020310-02  
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Project Number:  
2015-35-02C

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AS NOTED  
Checked by:  
W.W.J.

Date:  
03-13-2019  
Drawn by:  
W.K.M.

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Environmental, Engineering & Construction

Ramapo College of New Jersey  
505 Ramapo Valley Road  
Mahwah, New Jersey 07430  
for  
Hazardous Materials Abatement Plans  
Library & Learning Commons

Drawing Title:  
West  
Elevation  
Abatement  
Plan

Drawing No.

HA.4

Rev.	Date:	By:

## SECTION 02 82 13 – REMOVAL AND DISPOSAL OF ASBESTOS-CONTAINING MATERIALS

### PART 1 – GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Section, apply to this Section.

#### 1.2 CONTRACTOR REQUIREMENTS AND QUALIFICATIONS

- A. All work involving the removal and disposal of asbestos-containing materials shall be accomplished by a State of New Jersey, Department of Labor and Workforce Development (NJDOLE), licensed Asbestos Abatement Contractor.
- B. All employees shall possess and maintain on their person a valid asbestos worker or supervisor certification issued by the State of New Jersey, Department of Labor and Workforce Development, while working on this project.
- C. The Contractor shall furnish evidence that each worker and supervisor has been given medical examinations and respiratory fit tests within the previous twelve (12) months in accordance with United States Department of Labor, Occupational Safety and Health Administration (OSHA) 29 CFR 1910 and 29 CFR 1926 requirements.
- D. The Contractor shall be responsible for securing the work area(s) at the end of the shift, and all on-site waste containers/dumpsters. In addition, failure to comply with all site health and safety requirements, these Technical Specifications, and all applicable local, State and Federal regulations will require issuance of a Stop Work order by the Owner's Representative.
- E. Prior to commencement of work, the Contractor shall inspect areas in which work is to be performed. Prepare a listing of damage to structure, surfaces, equipment or of surrounding properties which could be misconstrued as damage resulting from the work. Photograph or videotape existing conditions as necessary to document conditions. Submit a copy of these photos or tapes to the Owner's Representative prior to starting work.
- F. All electrical connections, except to outlets and extension cords, will require the Contractor to utilize a licensed Electrician.
- G. In buildings required by the Uniform Construction Code (UCC) to be of noncombustible construction, all materials used to construct separation barriers must meet the UCC, building subcode requirements for that building. Polyethylene sheeting shall be a nominal six (6) mil and must be flame resistant.

#### 1.3 NOTIFICATIONS

- A. Send written notification as required by USEPA, National Emission Standards for Hazardous Air Pollutants (NESHAP), Asbestos Regulations (40 CFR, Part 61, Sub-part

M), to the regional asbestos NESHAP Contact at least ten (10) business days prior to beginning any work on asbestos-containing materials. Send notification to the following address for REGION 2, as applicable:

1. United States Environmental Protection Agency- Region 2  
Division of Enforcement and Compliance Assistance  
Air Compliance Branch (DECA-ACB)  
290 Broadway - 21st Floor  
New York, NY 10007-1866

Send written notifications to the State Agencies listed, as applicable:

2. New Jersey Department of Environmental Protection  
Division of Solid and Hazardous Waste  
P.O. Box 414  
Trenton, NJ 08625-0414
3. New Jersey Department of Community Affairs  
Division of Codes and Standards  
Asbestos Safety Unit  
101 South Broad Street  
P.O. Box 816  
Trenton, NJ 08625-0816
4. New Jersey Department of Health and Senior Services  
Indoor Environments Program  
Consumer and Environmental Health Services  
P.O. Box 360  
Trenton, NJ 08625-0360
5. New Jersey Department of Labor & Workforce Development  
Division of Public Safety & Occupational Safety & Health  
Asbestos Control & Licensing Section  
1 John Fitch Plaza  
P.O. Box 949  
Trenton, NJ 08625-0949

- B. Floor tile and mastic removal: The Contractor shall submit the State of New Jersey, Department of Health and Senior Services “CONTRACTOR INFORMATION FOR NON-FRIABLE ASBESTOS WORK ACTIVITIES—Exemption Request”.

Send written exemption request to:

1. New Jersey Department of Health  
Consumer, Environmental & Occupational Health Service  
PO Box 369  
Trenton, NJ 08625-0369

- C. Floor tile and mastic removal: Send written “NOTIFICATION OF NON-FRIABLE ASBESTOS WORK ACTIVITIES” as required by State of New Jersey, Department of Health and Senior Services at least 10 business days prior to beginning any work for non-

friable asbestos-containing materials removal. Send notification to the following address:

1. New Jersey Department of Health  
Consumer, Environmental & Occupational Health Service  
PO Box 369  
Trenton, NJ 08625-0369

D. Construction Permit

1. The Contractor shall be responsible for obtaining a construction permit in accordance with N.J.A.C. 5:23-2.

E. Regulatory Compliance

1. The Contractor shall furnish documentation to the building Owner or his designated representative that the firm and its employees are familiar with the following regulations of the United States Department of Labor, Occupational Safety and Health Administration (OSHA) and the United States Environmental Protection Agency (EPA) relating to the application, removal, disposal, and treatment of asbestos:
  - a. OSHA regulations, namely: 29 CFR 1910.1001, 29 CFR 1926.58 and 29 CFR 191.134, Respiratory Protection and 29 CFR 1910.20, Access to Employee Exposure and Medical Records.
  - b. EPA regulations, namely: Subparts A and M of 40 CFR Part 61, National Emissions Standards for Hazardous Air Pollutants.
2. One copy of each of the regulations cited in Article 1.4.E.1 shall be available in the Contractor's business office and one copy of each shall be maintained in view at the job site, available to both the public and the Contractor's employees.
3. The Contractor shall display at the job site, copies of documents required in Articles 1.4.A-C.
4. The Contractor shall be responsible for controlling access at the work site and shall maintain a daily log of personnel conducting asbestos removal activities. A list of worker names shall be posted with their start and stop times for each day. Copies of the daily log shall be given to the Project Monitor at the end of the project.
5. The Contractor shall strictly adhere to all precautions necessary for the safety and health of workers in accordance with provisions of OSHA Standards 29 CFR Part 1926, Construction Standards, and 29 CFR 1910, General Industry Standards. The applicable parts of NIOSH Health Hazard Evaluation Report Number HETA 84-321-1590 shall be adhered to.

1.4 CONTRACTOR SUBMITTALS

- A. The Asbestos Abatement Contractor shall submit the following information to the Owner's representative prior to mobilization at the worksite:
  1. Notification forms submitted to State and Federal agencies;

2. Inspection report of existing site conditions;
  3. Supervisor's license;
  4. Written Respiratory Protection Program and proof of OSHA compliance with 29 CFR 134;
  5. Safety Data Sheets (SDS) for all chemical agents brought onto the site;
- B. After completion of work on this project the Asbestos Abatement Contractor shall submit the following information to the Owner:
1. Daily activity reports and personnel sign-in sheets
  2. Visitations; authorized and unauthorized
  3. Special or unusual events
  4. Waste material disposal manifests

#### 1.5 DEFINITIONS

- A. The following words, terms and abbreviations, when used in this section, shall have the following meanings unless the context clearly indicates otherwise.
1. Abatement - Procedures to control fiber release from asbestos-containing materials; which include removal, encapsulation, enclosure, repair, demolition and renovation activities.
  2. Airlock - A serial arrangement of rooms whose doors are spaced a minimum of four (4) feet apart so as to permit ingress or egress through one (1) room without interfering with the next and constructed in such a manner as to prevent or restrict the free flow of air in either direction.
  3. Air Monitoring - The process of measuring the fiber content of a known volume of air collected during a specific period of time. The procedure utilized for asbestos follows the NIOSH Method 7400. For clearance air monitoring, electron microscopy methods may be utilized for lower limits of detection and specific fiber identification.
  4. Amended Water - Water to which a surfactant has been added.
  5. Asbestos - The asbestiform varieties of serpentinite (chrysotile), riebeckite (crocidolite), cummingtonite-grunerite, anthophyllite, and actinolite-tremolite. For purposes of determining respiratory and worker protection both the asbestiform and non- asbestiform varieties of the above minerals and any of these materials that have been chemically treated and/or altered shall be considered as asbestos.
  6. Asbestos-Containing Material (ACM) - Material composed of asbestos of any type

and in an amount greater than 1% by weight, either alone or mixed with other fibrous or non-fibrous materials.

7. Asbestos-Containing Waste Materials - Any material that is or suspected of being or any material contaminated with an asbestos-containing material, which is to be removed from a work area for disposal.
8. Authorized Personnel - The Owner, the Owner's representative, Asbestos Abatement Contractor personnel, Asbestos Safety Control Monitor personnel, emergency personnel, or a representative of any Federal, State or local regulatory agency or other personnel under contract for or having jurisdiction over the project.
9. Barrier - Any surface that seals off the work area to inhibit the movement of fibers.
10. Breathing Zone - A hemisphere forward of the shoulders with a radius of approximately six to nine inches (6" - 9").
11. Building Owner - The Owner or his authorized representative.
12. Category I Non-friable ACM - Asbestos-containing packing, gaskets, resilient floor covering and asphalt roofing products containing more than one (1) percent asbestos as determined using the method specified in appendix A, subpart F, 40 CFR part 763, section 1, Polarized Light Microscopy.
13. Category II Non-friable ACM - Any material, excluding Category I non-friable ACM, containing more than 1 percent asbestos as determined using the methods specified in appendix A, subpart F, 40 CFR part 763, section 1, Polarized Light Microscopy that, when dry, cannot be crumbled, pulverized, or reduced to powder by hand pressure.
14. Ceiling Concentration - The concentration of an airborne substance that shall not be exceeded.
15. Clean Room - An uncontaminated area or room which is a part of the worker decontamination enclosure system with provisions for storage of worker's street clothes and clean protective equipment.
16. Contractor - The Asbestos Abatement Contractor licensed by the State of New Jersey, Department of Labor.
17. Critical Barrier - Two layers of nominal six (6) mil polyethylene sheeting that completely seals off the work area to prevent the distribution of fibers to the surrounding area, such as the opening between the top of a wall and the underside of ceiling construction, electrical outlets, non-removable lights, HVAC systems, windows, doorways, entranceways, ducts, grilles, grates, diffusers, wall clocks, speaker grilles, floor drains, sink drains, etc.
18. Curtained Doorway - A device to allow ingress or egress from one room to another while permitting minimal air movement between the rooms, typically constructed by placing three (3) weighted overlapping sheets of plastic over an existing or

temporarily framed doorway, securing each along the top of the doorway, securing the vertical edge of the two outer sheets along one vertical side of the doorway and securing the vertical edge of the middle sheet along the opposite vertical side of the doorway. Other effective designs are permissible.

19. Decontamination Enclosure System - A series of connected rooms, separated from the work area and from each other by air locks, for the decontamination of workers and equipment.
20. Disposal Bag – six (6) mil thick leak-tight plastic bags used for transporting asbestos waste from work and to disposal site. Each is labeled as follows:

**DANGER**  
**CONTAINS ASBESTOS FIBERS**  
**MAY CAUSE CANCER**  
**CAUSES DAMAGE TO LUNGS**  
**DO NOT BREATHE DUST**  
**AVOID CREATING DUST**  
**ASBESTOS, CLASS 9, RQ, NA 2212**

The Contractor shall also label all disposal bags and/or containers with the name of the waste generator (Owner) and the location from which the waste was generated; all in accordance with the USEPA NESHAPS regulation - 40 CFR Part 651, Subpart M.

21. Encapsulant - A liquid material which can be applied to asbestos-containing material which controls the possible release of asbestos fibers from the material either by creating a membrane over the surface (bridging encapsulant) or by penetrating into the material and binding its components together (penetrating encapsulant).
22. Encapsulation - The application of an encapsulant to asbestos-containing materials to control the release of asbestos fibers into the air.
23. Filter - A media component used in respirators to remove solid or liquid particles from the inspired air.
24. Flame-Resistant Polyethylene Sheeting - A single polyethylene film in the largest sheet size possible to minimize seams, nominal six (6) mil thick, conforming to requirements set forth by the National Fire Protection Association Standard 701, Small Scale Fire Test for Flame-Resistant Textiles and Films.
25. Friable Asbestos Material - Material that contains more than 1% asbestos by weight and that can be crumbled, pulverized, or reduced to powder by hand pressure when dry.
26. HVAC - Heating, Ventilation and Air Conditioning system.
27. HEPA Filter - A High Efficiency Particulate Air (HEPA) filter capable of trapping and retaining 99.97% of asbestos fibers greater than 0.3 microns in length.

28. HEPA Filter Vacuum Collection Equipment (or vacuum cleaner) - High efficiency particulate air filtered vacuum collection equipment with a filter system capable of collecting and retaining asbestos fibers. Filters should be of 99.97% efficiency for retaining fibers of 0.3 microns or larger.
29. Negative Pressure - Air pressure lower than surrounding areas, generally caused by exhausting air from a sealed space (work area).
30. Negative Pressure Respirator - A respirator in which the air pressure inside the respirator inlet covering is positive during exhalation in relation to the air pressure of the outside atmosphere and negative during inhalation in relation to the air pressure of the outside atmosphere.
31. Negative Pressure Air Filtration Device (AFD) - A local exhaust system device, utilizing HEPA filtration capable of maintaining a negative pressure inside the work area and a constant air flow from adjacent areas into the work area and exhausting that air outside the work area.
32. Owner's Representative(s) – USA Environmental Management, Inc., represented on-site by an Industrial Hygiene Technician (IHT) for all non-permitted work and an Asbestos Safety Technician (AST), certified by the New Jersey Department of Community Affairs, for all permitted work. The IHT/AST shall ensure compliance with these Technical Specifications; all applicable local, State and Federal Regulations.
33. Personal Monitoring - Sampling of the asbestos fiber concentrations within the breathing zone of an employee.
34. Prior Experience - Experience required of the contractor on asbestos projects of similar nature and scope to insure capability of performing the asbestos abatement in a satisfactory manner. Similarities shall be in areas related to material composition, project size, abatement methods required, number of employees and the engineering, work practice and personal protection controls required.
35. Regulated Asbestos-Containing Material (RACM) - (a) Friable asbestos material, (b) Category I Non-friable ACM that has become friable, (c) Category I Non-friable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading, or (d) Category II Non-friable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of demolition or renovation operations.
36. Removal - The stripping of any asbestos-containing materials from surfaces or components of a facility.
36. Renovation - Altering in any way one or more facility components. Operations in which load-supporting structural members are wrecked or taken out are excluded.
37. Respirator - A device designed to protect the wearer from the inhalation of harmful



atmospheres.

38. Shower Room - A room between the clean room and the equipment room in the worker decontamination enclosure with hot and cold or warm running water controllable at the tap and suitably arranged for complete showering during decontamination.
39. Surfactant - A chemical wetting agent added to water to improve penetration, thus reducing the quantity of water required for a given operation or area.
40. Time Weighted Average (TWA) - The average concentration of a contaminant in air during a specific time period.
41. Visible Emissions - Any emissions containing particulate asbestos material that are visually detectable without the aid of instruments. This does not include condensed uncombined water vapor.
42. Water Column (w.c.) - A unit of measurement for pressure differential.
43. Wet Cleaning - The process of eliminating asbestos contamination from building surfaces and objects by using cloths, mops or other cleaning utensils that have been dampened with amended water or diluted removal encapsulant and afterwards thoroughly decontaminated or disposed of as asbestos contaminated waste.
44. Work Area - Designated rooms, spaces, or areas of the project in which asbestos abatement actions are to be undertaken or which may become contaminated as a result of such abatement actions. A contained work area is a work area that has been sealed, plasticized and equipped with a negative pressure air-filtration system.
45. Worker decontamination enclosure - A decontamination system consisting of a clean room, a shower room, and an equipment room separated from each other and from the work area by airlocks and curtained doorways. This system is used for all worker entrances and exists to and from the work area and for equipment pass out for small jobs.

#### 1.6 CODES & STANDARDS RELATIVE TO ASBESTOS ABATEMENT

- A. Except to the extent that more explicit or more stringent requirements are written directly into the Contract Documents, all applicable codes, regulations and standards have the same force and effect (and are made a part of the Contract Documents by reference) as if copied directly into the Contract Documents, or as if published copies are bound herewith.
- B. The Contractor shall assume full responsibility and liability for the compliance with all applicable Federal, State, and local regulations pertaining to work practices, hauling, disposal, and protection of workers, visitors to the site, and persons occupying areas adjacent to the site. The Contractor is responsible for providing medical examinations and maintaining medical records of personnel as required by the applicable federal, state and local regulations. The Contractor shall hold the Owner and the Owner's representative harmless for failure to comply with any applicable work, hauling, disposal, safety, health

or other regulation on the part of himself, his employees, or subcontractors.

- C. State of New Jersey requirements which govern asbestos abatement work or hauling and disposal of asbestos waste materials include but are not limited to the following:

Asbestos Licenses and Permits

New Jersey Department of Labor & Workforce Development  
Division of Public Safety & Occupational Safety & Health  
Asbestos Control & Licensing Section  
1 John Fitch Plaza  
P.O. Box 949  
Trenton, NJ 08625-0949

1. Asbestos Hazard Abatement Sub-code - N.J.A.C. 5:23-8

New Jersey Department of Community Affairs  
Division of Codes and Standards  
Asbestos Safety Unit  
101 South Broad Street  
P.O. Box 816  
Trenton, NJ 08625-0816

2. Asbestos Training Courses - N.J.A.C. 8:60 and 12:120

New Jersey Department of Health and Senior Services  
Indoor Environments Program  
Consumer and Environmental Health Services  
P.O. Box 360  
Trenton, NJ 08625-0360

3. Disposal Regulations - N.J.A.C. 7:26

New Jersey Department of Environmental Protection  
Division of Solid and Hazardous Waste  
P.O. Box 414  
Trenton, NJ 08625-0414

- D. Standards which apply to asbestos abatement work of hauling and disposal of asbestos waste materials include but are not limited to the following:

1. American National Standards Institute (ANSI)  
25 West 43rd Street, 4th floor  
New York, NY 10036

- *Fundamentals Governing the Design and Operation of local Exhaust Systems Publication Z9.2-79.*
- *Practices for Respiratory Protection Publication Z88.2-80.*

2. American Society for Testing and Materials (ASTM)  
100 Barr Harbor Drive, P.O. Box C700  
West Conshohocken, PA 19428-2959

- *Safety and Health Requirements Relating to Occupational Exposure to Asbestos E 849-82.*
- *Specification for Encapsulants for Friable Asbestos Containing Building Materials Proposal P-189.*

## PART 2 – SCOPE OF WORK

### 2.1 SUMMARY OF WORK

This section covers the furnishing of all labor, materials, facilities, equipment, services, permits and agreements necessary to perform the work required for asbestos abatement in accordance with these Technical Specifications, United States Environmental Protection Agency (USEPA) and OSHA regulations, NIOSH recommendations, State of New Jersey regulations and other applicable federal, state and local government regulations. Wherever there is a conflict or overlap of the above references the most stringent provisions shall apply. It shall be the Contractor's responsibility to verify exact quantities and locations of all asbestos-containing materials. Any quantities shown are for informational purposes only. It is USA Environmental Management, Inc., understanding that the Contractor has verified the materials and quantities to be removed under this scope of work and has priced the work accordingly.

### 2.2 DESCRIPTION OF THE WORK

- A. Site:  
Ramapo College of New Jersey  
Library & Learning Commons  
505 Ramapo Valley Road  
Mahwah, New Jersey 08743
- B. Contractor shall remove and dispose of asbestos-containing materials, via non-friable methods, as specified in the Contract Documents and in accordance with N.J.A.C. 5:23-8.20, including:
1. Black tar coating with tar paper on structural steel, per Section 02 82 13, 2.7, via intact removal methods;
  2. Black exterior window glazing, per Section 02 82 13, 2.7, via intact removal methods; and
  3. Black/white sealant at interface of awning and slate panels, per Section 02 82 13, 2.8, via non-friable procedures.
- C. In addition, the Contractor shall spot remove black tar coating with tar paper on structural steel to allow for the metal components to be disassembled/demolished and/or clean for new installation. Spot removal shall be conducted within a negative pressure enclosure.
1. Removal shall include of all residue and persistent materials to accommodate the disassembling/demolition or new installation of components to metal. If present, all residues shall be removed from any substrate where black tar coating with tar

paper exists on metal, via methods utilized to maintain the non-friable nature of the asphaltic materials (i.e. grinding shall not be allowed). Stained substrate elements may be left in place only where they will not interfere with new installation.

D. Quantities:

1. Black tar coating with tar paper on structural steel quantities shall be field verified. Removal shall be coordinated with General Contractor. Any locations indicated on the Contract Drawings are approximate. The Contractor shall review all Contract Documents and field conditions to determine the extent of removal.
2. Black window glazing - 82 Window Units (~1,640 Linear Feet).
3. Black/white sealant at interface of awning and slate panels – 30 Linear Feet.

E. Refer to all Contract Drawings for locations of all asbestos-containing materials to be removed. Coordinate with the General Contractor

2.3 ADDITIONAL INFORMATION

- A. The Contract Drawings are designed to compliment the Technical Specifications. Wherever conflicts arise between the Contract Drawings and the Technical Specifications, the more stringent shall apply.
- B. Prepare all asbestos-containing materials for transportation and disposal in accordance with NEHAPS, OSHA and the United States Department of Transportation (USDOT) asbestos waste handling requirements.
- C. The Contractor shall be aware that electrical, communication and other utility lines may exist in proximity to some locations where asbestos-containing material is to be removed. The Contractor shall exercise caution with his/her activities during preparation, removal, clean-up and final cleaning operations associated with asbestos abatement in these work areas, to prevent damaging said electrical, communication and other utility lines. Where possible, the Contractor shall cautiously move and secure the aforementioned items.
1. Should the Contractor damage any electrical, communication and/or other utility lines, the Contractor shall be responsible for either the cost to the Owner to repair/replace damaged components or shall arrange for the components to be repaired/replace to the Owner's specifications with no additional cost to the Owner.
  2. The Owner shall be the **SOLE** deciding factor as to which option referenced above the Contractor shall implement to repair/replace electrical, communication and/or other utility lines that are damaged as a result of the asbestos abatement activities in these work area locations.
  3. Damage caused by the Contractor to surfaces, finishes and building components shall be restored to their existing conditions. The Contractor shall be responsible for either the cost to the Owner to restore damaged surfaces, finishes and building

components or shall arrange for the restoration to the Owner's specifications with no additional cost to the Owner.

- D. The Contractor shall utilize proper protective equipment (PPE) such as safety glasses, disposable gloves, protective suits, safety shoes and HEPA cartridge equipped full-face respirators and other appropriate personal protective equipment when handling asbestos contaminated materials during pre-cleaning activities.
- E. Security shall be required as follows:
  - 1. The Owner shall be responsible to provide access to and to close the building each shift. The Contractor shall be responsible to ensure protection against damage or vandalism to separation barriers, engineering systems, monitoring devices, work-related equipment or any other equipment.
- F. The Owner shall provide continuous unlimited access for the IHT/AST in all occupied spaces for installation, maintenance, and data collection from monitoring systems.
- G. The Contractor shall coordinate the location of all waste vehicles with the Owner. The Owner shall approve all locations of waste vehicles prior to the waste vehicle's arrival.

#### 2.4 STANDARD OPERATING PROCEDURES

- A. The Contractor shall develop and implement a written standard operating procedure for abatement work to ensure maximum protection and safeguard from asbestos exposure of the workers, visitors, general public and the environment.
- B. The standard operation procedure shall ensure:
  - 1. Proper protective clothing and respiratory protection prior to entering the work area.
  - 2. Safe work practices in the work place, including provisions for inter-room communications, exclusion of eating, drinking, smoking or breaking of respiratory protection in any way.
  - 3. Packing, labeling, loading, transporting and disposal of asbestos-containing materials in a way that minimizes exposure and contamination.
  - 4. Proper exit practices from the workspace to the outside through the decontamination facility.
  - 5. Emergency evacuation for medical or safety to minimize exposure.
  - 6. Safety from accidents in the work area, especially from electrical shocks, slippery surfaces and entanglements in loose hoses, temporary wiring and other equipment.
  - 7. Provisions for effective supervision and personnel air monitoring during work.
  - 8. Engineering systems that minimize exposure to fibers in the work place.

- C. Perform OSHA 8-hour Time Weighted Average personal exposure air monitoring in accordance with 29 CFR 1926.1101. OSHA monitoring is solely the responsibility of the Contractor, and the Contractor shall ensure that the Contractor's Supervisor performs OSHA monitoring in accordance with 29 CFR 1926.1101. The Owner's Representative is not responsible for the Contractor's compliance with OSHA monitoring.
- D. Provide Personal Protective Equipment (PPE) to the Owner's Representative and inspector's representing Federal, State and local agencies, as required to perform progress inspections of the work.

2.5 NOTIFICATIONS, WARNING SIGNS, LABELS AND POSTERS

- A. At the entrance the work area and/or decontamination unit, the Contractor's ingress/egress point to the building and the exterior door that leads from the exterior of the building for the waste removal route, and all sides of the waste dumpster, post an approximate twenty by fourteen inch (20" x 14") manufactured caution sign displaying the following legend with letter sized and styles of a visibility required by 29 CFR 1926:

**DANGER  
ASBESTOS  
MAY CAUSE CANCER  
CAUSES DAMAGE TO LUNGS**

**AUTHORIZED  
PERSONNEL ONLY**

**WEAR  
RESPIRATORY PROTECTION  
AND PROTECTIVE CLOTHING  
IN THIS AREA**

- B. Disposal/Waste Bags/Containers shall be labeled as follows:

**DANGER  
CONTAINS ASBESTOS FIBERS  
MAY CAUSE CANCER  
CAUSES DAMAGE TO LUNGS  
DO NOT BREATHE DUST  
AVOID CREATING DUST  
ASBESTOS, CLASS 9, RQ, NA 2212**

In addition, the Contractor shall also label all disposal bags and/or containers with the name of the waste generator (Owner) and the location from which the waste was generated; all in accordance with the USEPA NESHAPS regulation - 40 CFR Part 651, Subpart M.

- C. Provide other signs, labels, warnings and posted instructions that are necessary to protect, inform and warn people of the hazard from asbestos exposure. Post in a prominent and convenient place for the workers a copy of the latest applicable regulations from OSHA, USEPA and NIOSH.

- D. Post ten (10) day Notifications to the USEPA, New Jersey Department of Community Affairs (when applicable), New Jersey Department of Labor and Workforce Development, New Jersey Department of Environmental Protection and New Jersey Department of Health and Senior Services, at the entrance to the work area(s).
- E. Post Construction Permits, if applicable, at the entrance to the work area(s).

## 2.6 DECONTAMINATION UNITS

### A. Description of Work:

- 1. Provide personnel decontamination for each work area as indicated in the Contract Documents. One (1) stage or three (3) stage as needed.

### B. Personnel Decontamination Unit:

- 1. Provide a personnel decontamination unit consisting of a serial arrangement of connected rooms or spaces, clean room, shower room and equipment room. Do not allow parallel routes for entry or exit. Provide temporary lighting within decontamination units as necessary to reach a lighting level of 100 foot candles.
- 2. Clean room: Provide a room that is physically and visually separated from the rest of the building for the purpose of changing into protective clothing.
  - a. Construct using two (2) individual layers of polyethylene sheeting, at least six (6) mil in thickness on all sides.
  - b. Locate so that access to the work area from the changing room is through shower room.
  - c. Separate changing room from the building by a three (3) sheet plastic, weighted, flapped doorway.
  - d. Require workers to remove all street clothes in this room, dress in clean disposable coveralls, and respiratory protective equipment. Do not allow asbestos contaminated items to enter this room. Require workers to enter this room either from outside the structure dressed in street clothes, or naked from the showers.
  - e. Maintain floor of clean room dry and clean at all times. Do not allow overflow water from shower to wet floor in clean room.
  - f. Damp wipe all surfaces twice after each shift change with a disinfectant solution.
  - g. Provide posted information for all emergency phone numbers and procedures.
- 3. Shower Room: Provide a completely watertight operational shower to be used for transit by cleanly dressed workers heading for the equipment room/work area from the clean room, or for showering by workers headed out of the work area after undressing in the equipment room.
  - a. Construct room by providing a shower pan and shower walls in a configuration that will cause water running down walls to drip into pan.
  - b. Provide a three (3) tier plastic flapped doorway at the entrance to the shower

- chamber.
  - c. Provide shower head and controls.
  - d. Provide temporary extensions of existing hot and cold water and drainage, as necessary for a complete and operational shower.
  - e. Provide a soap dish and a continuously adequate supply of soap and maintain in sanitary condition.
  - f. Arrange so that water from showering does not splash into the clean or equipment rooms.
  - g. Separate from equipment room by a three (3) sheet plastic, weighted, flapped doorway.
4. Equipment Room (contaminated area): Require work equipment, footwear and additional contaminated work clothing to be left here. This is a change and transit area for workers.
- a. Separate this room from the work area by a three (3) sheet plastic, weighted, flapped doorway.
5. Decontamination Sequence: The Contractor shall require that all workers adhere to the following sequence when entering or leaving the work areas.
- a. Entering Work Area: Worker enters clean room and removes street clothing, puts on clean disposable coveralls and respirator, and passes through the shower room into the equipment room. Any additional clothing and equipment left in equipment room needed by the worker are put on in the equipment room. Worker proceeds to the work area.
  - b. Exiting Work Area: Before leaving the work area, require the worker to remove all gross contamination and debris from coveralls and feet.
  - c. The worker then proceeds to the equipment room and removes all clothing except respiratory protection equipment.
  - d. Extra work clothing such as boots, hard hats, goggles, gloves, etc., are to be stored in the equipment room.
  - e. Disposable coveralls are placed in a bag for disposal with other material.
  - f. Require that decontamination procedures be followed by all individuals leaving the work area.
  - g. After showering, the worker moves to the clean room and dresses in either new coveralls for another entry or street clothes if leaving.
- C. Construction of the Decontamination Units:
- 2. Walls and Ceiling: Construct airtight walls and ceiling using two (2) layers of polyethylene sheeting, at least six (6) mil in thickness. Attach to existing building elements or a temporary framework.
  - 3. Floors: Use two (2) layers of six (6) mil polyethylene sheeting to cover floors in all areas of the decontamination units.
  - 4. Flap Doors: Fabricate from three (3) overlapping sheets with openings a minimum of four (4) feet wide. Configure so that sheeting overlaps adjacent surfaces. Weigh sheets at bottoms as required so that they quickly close after being released. Put



arrows on sheets to indicate direction of overlap and/or travel. Provide a minimum of four (4) feet between entrance and exit of any room.

D. Cleaning of Decontamination Units:

1. Clean debris and residue from inside of decontamination units on a daily basis or as otherwise indicated. Damp wipe twice or hose down all surfaces after each shift change. Clean debris from shower pans on a daily basis.

E. Signs:

1. Post an approximately 20" x 14" manufactured caution sign at each entrance to the work areas displaying the following legend with letter sizes and styles of a visibility required by 29 CFR, Part 1926:

Provide signs in both English and Spanish.

LEGEND:

**DANGER  
ASBESTOS  
MAY CAUSE CANCER  
CAUSES DAMAGE TO LUNGS**

**AUTHORIZED  
PERSONNEL ONLY**

**WEAR  
RESPIRATORY PROTECTION  
AND PROTECTIVE CLOTHING  
IN THIS ARE**

Provide spacing between respective lines at least equal to the height of the respective upper line.

2.7 REMOVAL OF INTACT ASBESTOS-CONTAINING MATERIALS

A. DESCRIPTION OF WORK

1. Work specified herein is limited to those materials that can be removed intact and in whole sections such as, but not limited to:
  - a. Black tar coating with tar paper on structural steel; and
  - b. Window glazing;

B. PRODUCTS

1. Six (6) mil polyethylene sheeting
2. Spray glue

3. High quality duct tape
4. Garden sprayer
5. Amended water
6. Asbestos warning signs
7. Other equipment deemed necessary by the Contractor, such as man-lifts, fork lifts, etc.

C. EXECUTION OF WORK

1. Do not conduct work on the exterior if wind speeds are greater than 20 miles per hour. Work must stop and clean up must occur before rain begins.
2. The Contractor shall provide all ladders, scaffolding and/or other necessary equipment for the installation of all engineering controls and removal of materials.
3. For exterior removal:
  - a. Install one (1) layer of six (6) mil polyethylene sheeting, extending ten (10) feet out from the building, and extending twelve inches (12") up the building wall where work is being performed. Contractor shall overlap all seams by a minimum of twelve inches (12");
  - b. Install asbestos warning/caution tape a minimum of twenty feet (20') out in all directions where work is being performed;
  - c. Install critical barriers consisting of two (2) layers of fire retardant, six (6) mil polyethylene sheeting over all windows/walls from the interior side of the work areas.
4. A restricted area shall be established using warning tape extending at least 25 feet from the affected areas of the building or to the nearest vertical obstruction or the curb. Provide 3" wide red barrier tape printed with black lettered, "DANGER ASBESTOS REMOVAL". Locate barrier tape across all corridors, entrances and access routes to asbestos Work Area. Install tape 3' to 4' above the ground level.
5. A remote decontamination unit shall be constructed as indicated in the Contract Documents.
6. Removal activity shall not commence until a written Notice to Proceed has been issued by the IHT/AST. Approval of each work area for removal activity shall not, in any way, relieve the Contractor of his responsibility to ensure that non-work areas and items/equipment within each work area are protected from physical damage, or asbestos contamination from this project.
7. If necessary for disassembling/demolition, perform spot removal of existing asbestos-containing materials on metal. Spot removal shall be conducted within a negative pressure enclosure.

8. Mist the material with amended water.
9. Remove fasteners used to secure the non-friable asbestos materials to a substrate without disturbing the ACM.
10. Remove the non-friable ACM in whole sections and place on two (2) layers of six (6) mil polyethylene sheeting.
11. Package the ACM with the two (2) layers of polyethylene sheeting and seal all seams with spray-glue and duct tape.
12. Place appropriate warning signs and generator labels on the packaged ACM and place in the on-site waste container or Asbestos Abatement Contractor's registered vehicle, in accordance with the requirements set forth in this Technical Specification.
13. Personnel shall decontaminate in accordance with the requirements set forth in this Technical Specification.
14. Engineering controls shall remain operational until a satisfactory visual inspection, and if applicable, final clearance air samples have been collected and the clearance criteria achieved, as conveyed by the IHT.

## 2.8 CAULK/SEALANT ABATEMENT PROCEDURES

- A. The following procedures shall be followed while performing abatement of asbestos-containing caulking/sealant:
  1. The Contractor shall inspect and verify all ACM planned for removal from the subject building as described in Scope of Work.
  2. No asbestos abatement work including preparation shall be performed or continued without having proper notification and a State of New Jersey, Department of Labor and Workforce Development, certified asbestos supervisor at the work site.
  3. Workers performing the work must receive OSHA awareness training and work practices training related to asbestos disturbances and handling and must have a valid State of New Jersey, Department of Labor and Workforce Development asbestos worker license.
  4. Signs:
    - a. Post an approximately 20" x 14" manufactured caution sign at each entrance to the work areas displaying the following legend with letter sizes and styles of a visibility required by 29 CFR, Part 1926.
    - b. Provide signs in English

LEGEND:

**DANGER  
ASBESTOS**

**MAY CAUSE CANCER  
CAUSES DAMAGE TO LUNGS**

**AUTHORIZED  
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**WEAR  
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AND PROTECTIVE CLOTHING  
IN THIS ARE**

5. A restricted area shall be established using warning tape extending at least 25 feet from the affected areas of the building or to the nearest vertical obstruction or the curb. Provide 3" wide red barrier tape printed with black lettered, "DANGER ASBESTOS REMOVAL". Locate barrier tape across all corridors, entrances and access routes to asbestos Work Area. Install tape 3' to 4' above the ground level.
6. Install one (1) layer of six (6) mil polyethylene sheeting, extending ten (10) feet out from the work area, and extending twelve inches (12") up the wall where work is being performed. Contractor shall overlap all seams by a minimum of twelve inches (12").
7. The restricted area may be entered only by certified workers or authorized visitors.
8. The Contractor shall be responsible for the erection of critical barriers consisting of two (2) layers of fire retardant, six (6) mil polyethylene sheeting over all openings and access points which are within 25 feet of the affected ACM.
9. Contractor shall install and utilize fixed scaffolding or a man lift to facilitate removal of caulking from outside the building. Comply with all applicable OSHA fall protection requirements.
10. A remote decontamination unit shall be constructed as indicated in the Contract Documents.
11. All asbestos handlers shall wear two disposable suits, including gloves, hood and footwear, and appropriate respiratory equipment, after removing street clothes in the clean room.
12. ACM shall be sprayed with amended water in sufficient frequency and quantity for enhanced penetration. Sufficient time shall be allowed for penetration to occur prior to removal action or other disturbance-taking place. Dry removal of asbestos materials is prohibited.
13. Each abatement team shall be equipped with appropriate tools, rags, a portable supply of amended water, and a HEPA vacuum. After the ACM caulking/sealant material is adequately wetted, it shall be stripped using hand tools, with the ACM caulking/sealant material being directly bagged or dropped into a flexible catch basin and promptly bagged. The stripped joints shall then be HEPA vacuumed, and then wet-wiped, to remove any loose debris still in place.

8. Upon completion of the stripping at a location and before moving to the next, the surfaces of the immediate work area shall be rendered free of visible debris. No visible ACM shall remain; the IHT/AST shall inspect all surfaces prior to the Contractor moving to the next work area.
9. After the ACM removal and bagging, the bagged waste shall be HEPA-vacuumed then wet-cleaned and transferred into the airlock or into the shower room for double bagging, and thereafter the double-bagged waste shall be transferred outside the airlock or outside the clean room for its final transfer for storage in an enclosed waste container.

## 2.9 WORK AREA CLEAN UP

- A. All surfaces and Contractor equipment in the work area(s) shall be cleaned after completion of the removal activities.
- B. Walls and adjoining adjacent surfaces shall be wet cleaned.
- C. The polyethylene sheeting installed shall be rolled up keeping the top surface to the inside and placed into six (6) mil asbestos disposal bags for disposal as asbestos contaminated waste.
- D. Upon issuance of a satisfactory visual inspection, the Owner's representative shall proceed with the collection of final clearance air samples, if applicable.

## 2.10 ASBESTOS WASTE HANDLING AND DISPOSAL

- A. Disposal bags shall be six (6) mil, leak tight, and labeled in accordance with OSHA, NESHAPS, and the United States Department of Transportation (USDOT) regulations.
- B. Load all asbestos-containing waste material in disposal bags or leak-tight drums. All materials are to be contained in one (1) of the following:
  1. Two (2), six (6) mil disposal bags, or,
  2. Two (2), six (6) mil disposal bags and a fiberboard drum, or
  3. Two (2), six (6) mil disposal bags, and sealed steel drum.
- C. Two (2) layers of six (6) mil flame resistant polyethylene sheeting shall be utilized for wrapping large components not suited for disposal bags or drums.
- D. Duct tape shall be used to seal disposal bags and wrapped components.
- E. The Contractor's vehicle and/or dumpster shall be lined with a critical barrier of two (2) layers of six (6) mil flame resistant polyethylene sheeting. The Contractor's vehicle and/or dumpster utilized to transport the asbestos waste off-site, and the Waste Hauler shall be licensed by the New Jersey Department of Environmental Protection.

- F. Contractor shall remove waste from work area to waste dumpster only during times of minimum occupancy (i.e., at the end of the work shift when building occupancy is anticipated to be at its minimum).
- G. Maintain records of waste shipments in accordance with NESHAPS 40 CFR Part 61, section 61.150, (d) 1-5 and (e).
- H. Notify the USEPA ID #27 approved landfill within ten (10) days prior to transportation of the asbestos-containing waste to the landfill. Provide the name and address of the landfill. Retain manifest from the landfill for all materials disposed. At the completion of asbestos abatement forward all manifests to the Owner.
- I. On-site activities shall not be considered complete until all waste is off-site, upon demobilization of the work area(s), after receipt of satisfactory final clearance air sample results.

### PART 3 – AIR MONITORING

#### 3.1 DESCRIPTION OF THE WORK

- A. This Section describes air monitoring to verify that the building beyond the work area and the outside environment remains uncontaminated. This Section also sets forth airborne fiber levels both inside and outside the work area as action levels, and describes the action required by the Contractor if an action level is met or exceeded.
- B. AIR MONITORING REQUIRED BY OSHA IS RESPONSIBILITY OF THE CONTRACTOR AND IS NOT COVERED IN THIS SECTION.

#### 3.2 BACKGROUND AIR MONITORING

- A. The Owner's Representative will conduct background environmental/daily air monitoring to detect faults in the abatement removal methods.
- B. Daily Air Monitoring (including the building interior adjacent to the work) shall be performed from the start of work to project decontamination, per shift. The Owner's Representative will collect air samples from locations adjacent to the work area, including critical barriers, the clean room of the decontamination unit and the waste removal route (as applicable).
- C. Phase Contrast Microscopy (PCM) sampling and analysis will be performed using the latest revision of NIOSH Method 7400.
- D. If any air sample exceeds the action level of 0.010 fibers per cubic centimeter, immediately and automatically stop all work except corrective action.

#### 3.3 FINAL CLEARANCE AIR MONITORING

- A. The Owner's Representative shall collect final clearance air samples at the completion of interior abatement activities and after a satisfactory clean-up inspection.

- B. Engineering controls, critical barriers and the decontamination unit shall remain during final clearance air sampling.
- C. All final clearance air samples will be taken using aggressive sampling techniques as follows:
  - 1. Before sampling pumps are started, the exhaust from forced-air equipment (leaf blower with 1 HP electric motor) will be swept against all walls, ceilings, floors, ledges and other surfaces in the room. This procedure will be continued for five (5) minutes per 10,000 cubic feet of air volume.
  - 2. One 20" diameter fan per 10,000 cubic feet of room volume will be mounted in a central location at approximately 2 meters above the floor, directed towards the ceiling and operated at low speed for the entire period of sample collection.
  - 3. Air samples will be collected in areas subject to normal air circulation away from room corners, obstructed locations, and sites near windows, doors or vents.
- D. A minimum of five (5) samples will be collected from the work area and analyzed in accordance with the method set forth in the AHERA Regulation 40 CFR Part 763 Appendix A.
  - 1. For work area(s) where more than 160 SF or 260 LF of asbestos-containing materials have been removed, final clearance samples shall be collected/analyzed utilizing Transmission Electron Microscopy (TEM).
  - 2. For work area(s) where less than 160 SF or 260 LF of asbestos-containing materials have been removed and/or for floor tile/mastic work areas (in any quantity of material) where a "Notification of Non-Friable Asbestos Work Activities" was submitted to the New Jersey Department of Health, final clearance samples shall be collected/analyzed utilizing Phase Contrast Microscopy (PCM).
  - 3. TEM samples shall be analyzed at a laboratory accredited by the American Industrial Hygiene Association, participating in the National Voluntary Laboratory Accreditation Program (NVLAP). PCM samples shall be analyzed in accordance with the most recent revision to NIOSH method 7400.
  - 4. Acceptable Clearance Criteria for work area demobilization and re-occupancy shall be as follows:
    - a. TEM: Average of less than 70 Structures per millimeter squared for all five (5) samples analyzed.
    - b. PCM: Less than 0.01 fibers per cubic centimeter.

#### PART 4 – PROJECT COMPLETION

##### 4.1 FINAL INSPECTION

- A. The Owner's Representative will perform a final visual inspection of the abatement work

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Leaning Commons  
Mahwah, Bergen County, New Jersey  
Ramapo Project No. 2015-35-02C

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Issued for Bid

area(s) to document the project has been completed in accordance with these Technical Specifications and all applicable Local, State and Federal regulations.

END OF SECTION 02 82 13



## SECTION 02 83 00 – TREATMENT OF LEAD IN CONSTRUCTION

### PART 1 – GENERAL REQUIREMENTS

#### 1.1 RELATED DOCUMENTS

- A. General and Supplementary General Conditions, and the Contract Drawings apply to this Section.

#### 1.2 CONDITIONS

- A. For the purposes of this document, the term Contractor shall apply to any and all Trades that will disturb surfaces, components, objects, etc., coated with paint, shellac, varnish, stains, etc., and potentially generate dust, debris, airborne contaminants, etc., as a result of the Ramapo College of New Jersey, Learning Commons, Renovations & Upgrades.
- B. Based off of the age of construction, lead-containing paint as defined by the United States Department of Labor, Occupational Safety and Health Administration, (OSHA) is anticipated throughout all painted building components. OSHA does not establish a threshold for lead-containing paint. Therefore, the Contractor shall comply with 29 CFR 1926.62, and the New Jersey Public Employee Occupational Safety and Health (PEOSH) program, Indoor Air Quality Standard, N.J.A.C. 12:100-13.1 et seq.
- C. Work referenced within these Technical Specifications is not to address potential lead health issues and children, as outlined by N.J.A.C. 5:17, which is the New Jersey Lead Hazard Evaluation and Abatement Code; 40 CFR, Part 745, the Lead-Based Paint Poisoning Prevention in Certain Residential Structures, including child occupied buildings; and/or N.J.A.C. 5:10, the New Jersey Regulations for Lead-Safety Maintenance of Rental Housing.
- D. Treatment of Painted Surfaces: OSHA does not establish a threshold lead level to determine a coating as lead-based paint. As such, the Contractor shall utilize appropriate engineering controls and personal protective equipment when disturbing paint. This shall also apply for any renovation/demolition work that generates nuisance dust/particulates. Further, State Facilities are within the jurisdiction of the New Jersey Public Employees Occupational Safety and Health program, which requires, at a minimum, the use of engineering controls during construction work to minimize dust/particulates.
  - 1. To fulfill the requirements of OSHA, the disturbance, of any lead-containing painted surface, should be treated by a Contractor in accordance with 29 CFR 1926.62, the OSHA “Lead in Construction Standard.” In addition, State Facilities are within the jurisdiction of PEOSH. The New Jersey Air Quality Standard, N.J.A.C. 12:100-13.1 et seq., requires the Contractor’s engineering controls diffuse dust, stone and other small particles, toxic gases or other harmful substances in quantities hazardous to health by means of work area isolation, local ventilation and other protective devices.

2. OSHA's "Lead in Construction Standard" requires, at a minimum, the Contractor to provide a site specific Lead Safety Plan to address:
  - a. Worker protection, including respiratory protection;
  - b. Worksite contamination, clean-up, including personal hygiene, and waste disposal; and
  - c. Exposure monitoring for workers as required by the OSHA, for those persons whose trade will disturb painted surfaces as a result of renovation/demolition activities, paint refinishing, construction and re-construction, etc.

### 1.3 CONTINGENCY

- A. The intent of this Technical Specification is to provide information and guidance for the disturbance of surface coatings where the work shall generate dust, debris and airborne particulates that may be coated with lead-based paint or lead-containing paint. Should the appropriate Trade performing the work specified that generates these conditions as a result of related renovation/demolition require the use of a Lead Abatement Contractor, licensed by the State of New Jersey, Department of Community Affairs, (DCA), the Lead Abatement Contractor shall not be advertised as such, since the work specified in these Technical Specifications relates to the construction industry and not that of a lead hazard.

### 1.4 COORDINATION

- A. The Contractor shall coordinate all activities with the Owner's Representative; where the Trade performing the work specified herein is a sub-contractor, the sub-contractor shall coordinate all work with the Prime Contractor for coordination with the Owner's Representative.
- B. Coordination of work shall be notified, at a minimum within (48) hours of an event. The exception shall be that of emergency situations.

### 1.5 CONTRACT DOCUMENTS

- A. Contract Documents: Indicate the work of the Contract and related requirements and conditions that have an impact on the project. Related requirements and conditions that are indicated on the Contract Documents include, but are not necessarily limited to, the following:
  1. Applicable federal, state and local codes and regulations.
  2. Notices and Permits.
  3. Existing site conditions and restrictions on the use of the site.
  4. Work performed prior to work under this Contract.
  5. Alterations and coordination with existing work.

### 1.6 DEFINITIONS

- A. Definitions contained in this Section are not necessarily complete, but are general to the extent that they are not defined more explicitly elsewhere in the Contract Documents.
1. Indicated – This term refers to graphic representations, notes or schedules on the drawings, or other Paragraphs or Schedules in Specifications, and similar requirements in Contract Documents. Where terms such as "shown," "noted", "scheduled" and "specified" are used, it is to help locate the reference; no limitation on location is intended except as specifically noted.
  2. Directed – Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Owner's Representative," "requested by the Owner's Representative," and similar phrases. However, no implied meaning shall be interpreted to extend the Owner's Representative's responsibility into the Contractor's area of construction supervision.
  3. Approve – The term "approved," where used in conjunction with the Owner's Representative's action on the Contractor's submittals, application, and request, is limited to the responsibilities and duties stated in General and Supplementary Conditions. Such approval shall not release the Contractor from the responsibility to fulfill other Contract requirements.
  4. Regulation – The term "Regulations" includes laws, statutes, ordinances and lawful orders issued by authorities having jurisdiction, as well as rules, conventions and agreements within the construction industry that control performance of the work, whether they are lawfully imposed by authorities having jurisdiction or not.
  5. Furnish – The term "furnish" is used to mean "supply and deliver to the project site, ready for unloading, unpacking, assembly, installation, and similar operations."
  6. Install – The term "install" is used to describe operations at the project site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning and similar operations."
  7. Provide – The term "provide" means "to furnish and install, complete and ready for the intended use."
  8. Installer – An "Installer" is an entity engaged by the Contractor, either an employee, sub-contractor or sub-subcontractor for performance of a particular construction activity, including installation, erection, application and similar operations.
  9. Project Site – The Project Site is the space available to the Contractor for performance of the work, either exclusively or in conjunction with others performing other construction as part of the project. The extent of the project site is shown on the drawings and may or may not be identical with the description of the land upon which the project is to be built and/or the facility.

10. Testing Laboratories – A "testing laboratory" is an independent entity engaged to perform specific inspections or tests, either at the project site or elsewhere, to report on, and, if required, to interpret, results of those inspections or tests.
  11. Owner's Representative – The Owner's Representative will represent the Owner during construction. The Owner's Representative will advise and consult with the Owner. The Owner's instructions to the Contractor will be forwarded through the Owner's Representative.
  12. Project Administrator – The Project Administrator is a full time representative of the Owner at the job site with authority to stop the work upon verbal order if requirements of the Contract Documents are not met, or if in the sole judgment of the Project Administrator, Owner's Representative or Owner, the interests of the Owner, safety of any person or the Owner's property are jeopardized by the work.
  13. General Superintendent – This general superintendent is the Contractor's representative at the work site. This person will generally be the competent person required by OSHA in 29 CFR 1926.62.
- B. Definitions Pertaining to the Lead Abatement Industry (The definitions are provided for informational purposes, as applicable to these Technical Specifications; however, the disturbance of any coated surface shall not be completed as a lead abatement project.)
1. Abatement – Abatement of lead-based paint involves removal of lead-based paint or replacement of surfaces containing lead-based paint.
  2. Action Level – As defined in OSHA Construction Standard 29 CFR 1926.62, employee exposure, without regard to use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter ( $30 \mu\text{g}/\text{m}^3$ ) of air averaged over an 8-hour period. As used in this section, " $30 \mu\text{g}/\text{m}^3$  of air" refers to the action level.
  3. Amended Water – Water containing at least one ounce of five percent (5%) trisodium phosphate per gallon of water.
  4. Area Monitoring – Sampling of lead concentrations within and outside the lead control area and inside the physical boundaries which are representative of the airborne lead concentrations which may reach the breathing zone of personnel potentially exposed to lead.
  5. Atomic Absorption Spectroscopy – The analytical method of determining the lead content of a given sample.
  6. Physical Boundary – Area physically roped or partitioned off around a lead control area to limit unauthorized entry of personnel. As used in this section, "outside boundary" shall mean the same as "outside lead control area."

7. Lead Inspector/Risk Assessor – As used in this section, refers to a person with a current Lead Inspector/Risk Assessor permit issued by the State of New Jersey, Department of Health.
8. Change Rooms and Shower Facilities – Rooms within the designated physical boundary around the lead control area equipped with separated storage facilities for clean protective work clothing and equipment and for street clothes which prevent cross-contamination.
9. Decontamination Area – Area for removal of contaminated personal protective equipment (PPE).
10. Eight-Hour Time Weighted Average (TWA) – Airborne concentration of lead averaged over an 8-hour workday to which an employee is exposed.
11. High Efficiency Particulate Air (HEPA) Filter Equipment – Vacuuming equipment containing a UL 586 HEPA filter system capable of preventing passage of lead contaminated paint dust with an efficiency of 99.97 percent for all particulates greater than 0.3-micron size.
12. Lead – Metallic lead, inorganic lead compounds, and organic lead soaps. Exclude from the definition are other organic lead compounds.
13. Lead Control Area – An emission control area to prevent the spread of lead dust, paint chips, or debris from lead containing paint removal operations. The lead control area is isolated by physical boundaries to prevent unauthorized entry of personnel.
14. Permissible Exposure Limit (PEL) – 50 micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ) of air as an 8-hour time weighted average as determined by OSHA Construction Standard 29 CFR 1926.62.
15. Personal Monitoring – Sampling of lead concentrations within the breathing zone of an employee to determine the 8-hour time weighted average concentration in accordance with 29 CFR 1926.62. Samples shall be representative of the employee's work tasks. Breathing zone shall be considered an area within a hemisphere, forward of the shoulders, with a radius of six (6) to nine (9) inches from the center at the nose or mouth of an employee.
16. Wipe Sampling – Clearance testing procedures which determine the amount of existing lead-based paint surface dust by Atomic Absorption Spectroscopy Analysis are express in micrograms of lead per square foot.

## 1.7 CODES & STANDARDS

- A. Except to the extent that more explicit or more stringent requirements are written directly into the Contract Documents, all applicable codes, regulations and standards have the same force and effect (and are made a part of the Contract Documents by reference) as if copied directly into the Contract Documents, or as if published copies are bound herewith.

- B. The Contractor shall assume full responsibility and liability for the compliance with all applicable federal, state, and local regulations pertaining to work practices, hauling, disposal, and protection of workers, visitors to the site, and persons occupying areas adjacent to the site. The Contractor is responsible for providing medical examinations and maintaining medical records of personnel as required by the applicable Federal, State and Local regulations. The Contractor shall hold the Owner and the Owner's Representative harmless for failure to comply with any applicable work, hauling, disposal, safety, health or other regulation on the part of himself, his employees, or sub-contractors.
- C. A copy of the appropriate codes and standards, as referenced herein, shall be maintained at the project site.
- D. Conflicting Requirements: Where compliance with two (2) or more standards is specified, and they establish different or conflicting requirements for minimum quantities or quality levels, the most stringent requirement will be enforced, unless the Contract Documents indicate otherwise. Refer requirements that are different, but apparently equal, and uncertainties as to which quality level is more stringent to the Owner's Representative for a decision before proceeding.
- E. Incorporation of Publications: The publications listed below form a part of this Technical Specification to the extent referenced, where applicable. The publications referred within the text will be the basic designation only.
1. Code of Federal Regulations (CFR)
    - a. 29 CFR 1910.95 - Occupational Noise Exposure
    - b. 29 CFR 1910.134 - Respiratory Protection
    - c. 29 CFR 1910.1200 - Hazard Communication
    - d. 29 CFR 1910.1025 - Occupational Safety and Health Standards (Lead)
    - e. 29 CFR 1926.55 - Gases, Vapors, Fumes, Dusts, and Mists
    - f. 29 CFR 1926.59 - Hazard Communication
    - g. 29 CFR 1926.62 - Safety and Health Regulations for Construction (Lead)
    - h. 29 CFR 1926.103 - Respiratory Protection
    - i. 29 CFR 1926.453 - Aerial Lifts
    - j. 29 CFR 1926.502 - Fall Protection
    - k. 40 CFR 260 - Hazardous Waste Management Systems (General)
    - l. 40 CFR 261 - Identification and Listing of Hazardous Waste
    - m. 40 CFR 262 - Generators of Hazardous Waste
    - n. 40 CFR 263 - Transporters of Hazardous Waste
    - o. 40 CFR 264 - Owners and Operators of Hazardous Waste Treatment, Storage and Disposal facilities
    - p. 40 CFR 265 - Owners and Operators of Hazardous Waste Treatment, Storage and Disposal facilities
    - q. 40 CFR 171 - Standards for Transportation of Hazardous Materials
    - r. 40 CFR 172 - Hazardous Material Tables and Hazardous Materials Communications Regulations
    - s. 40 CFR 173 - General Requirements for Shipments and Packaging
    - t. 40 CFR 178 - Shipping Container Specifications

2. New Jersey Regulations

- a. N.J.A.C. 5:17 – New Jersey Lead Hazard Evaluation and Abatement Code
- b. N.J.A.C. 8:62 – New Jersey Standards for Lead Certification
- c. N.J.A.C. 7:26 – New Jersey Waste Disposal Requirements
- d. N.J.A.C. 12:100-13.1 – New Jersey Indoor Air Quality Standard

#### 1.8 PRE-PROJECT INSPECTION

- A. Prior to commencement of work, inspect areas in which work is to be performed. Prepare a listing of damage to structure, surfaces, equipment or of surrounding properties which could be misconstrued as damage resulting from the work. Photograph or videotape existing conditions, as necessary to document conditions. Submit a copy of these photos or tapes to the Owner's Representative prior to starting work.

#### 1.9 POTENTIAL ENVIRONMENTAL HAZARDS

- A. The disturbance or dislocation of paint or other coated surfaces may cause a release of lead dust, fumes, etc., within the building's atmosphere and/or the environment, thereby creating a potential health hazard to workmen, building occupants and the environment. Apprise all workers, supervisory personnel, sub-contractors, consultants and authorized visitors who will be at the job site of the seriousness of the hazard and of proper work procedures which must be followed. The building(s) may be occupied or unoccupied during all aspects of renovation/demolition.

#### 1.10 SUBMITTALS

- A. Pre-Project/During the Work Submittals: Upon request by the Owner and/or Owner's Representative, the Contractor shall submit:
  1. Written site specific Health and Safety Plan
  2. All Safety Data Sheets (SDS)
- B. Post Project Submittals: Upon completion of work on this project the Contractor shall submit the following information to the Owner, as requested:
  1. Daily activity reports and personnel sign-in sheets
  2. Minutes of meetings
  3. Visitations; authorized and unauthorized
  4. Special or unusual events
- C. Waste material disposal manifests shall be submitted for project close-out payment submittal.

#### 1.11 CONTRACTOR'S USE OF THE PREMISE

- A. The Contractor shall abide by all requirements for use of the premises at the facility. However, where not specified, the Contractor shall:
1. Confine operations, at the site, to the areas permitted under the Contract. Portions of the site beyond areas in which work is indicated are not to be disturbed. Conform to site rules and regulations affecting the work while engaged in project construction.
  2. Secure and obtain facility security regulations for Contractors. All facility security requirements are incorporated by reference. No additional compensation or time shall be allotted for failure to comply with the facility's security requirements.
  3. Keep existing driveways and entrances serving the premises clear and available to the Owner and his employees at all times. Do not use these areas for parking or storage of materials.
  4. Do not unreasonably encumber the site with materials or equipment. Confine stockpiling of materials and location of storage sheds to the areas indicated. If additional storage is necessary obtain and pay for such storage off site.
  5. Maintain existing building in a safe and weather tight condition throughout the construction period. Repair damage caused by construction operations. Take all precautions necessary to protect the building during the construction period.
  6. Keep public areas such as hallways, stairs, elevator lobbies and toilet rooms free from accumulation of waste, rubbish or construction debris.
  7. Smoking or open fires will not be permitted within the building enclosure or on the premises.
  8. Cooperate fully with the Owner and/or the Owner's Representative during construction operations to minimize conflicts with other Trades. Perform the work so as not to interfere with the Owner's operation.

#### 1.12 STOP WORK

- A. If the Owner, the Owner's Representative, or the Project Administrator presents a written stop work order, immediately and automatically stop all work. Do not recommence work until authorized in writing by the Owner or his/her appropriate representative.

### PART 2 – DESCRIPTION OF THE WORK

#### 2.1 SUMMARY

- A. The intent of this Technical Specification Section is provide information and guidance for the disturbance of surface coatings where the work shall generate dust, debris and airborne particulates, that may also be coated with lead paint. Should the appropriate Trade performing the work specified that generates these conditions as a result of related renovation/demolition require the use of a Lead Abatement Contractor, licensed by the



DCA, the Lead Abatement Contractor shall not be advertised as such, since the work specified in these Technical Specifications relates to the construction industry and not that of a lead hazard.

- B. Where present, turn-off and disconnect all electrical circuits inside or adjacent to the component to be removed.
- C. Existing forced air Heating, Ventilation and Air Conditioning (HVAC) systems shall be shut-down where work occurs, and protected with polyethylene sheeting to minimize the potential for dust, fumes, etc., migrating into these systems from the work area(s). The Contractor shall implement appropriate corrective measures to segregate an active system between work area(s) and adjacent occupied locations, such as “blanking;” these corrective measures shall be at no additional cost to the Owner/Project. Fresh air intakes for these systems shall be protected with two (2) layers of polyethylene sheeting, when work occurs outdoors and in proximity of such.
- D. The Contractor shall post appropriate OSHA warning signs as specified and required by 29 CFR 1926.62. The Contractor shall also post appropriate notices of construction related work, as per N.J.A.C. 12:100-13.1 et seq., indicating potential environmental issues (i.e., dust, gases, fumes, odors, etc.) and the location of SDSs. The Contractor shall provide for clearly marked emergency means of egress for the work areas specified. These notifications shall be placed at eye level and in languages consistent with the building population.
- E. The Contractor shall be liable for all costs associated with the replacement or repair of any utilities, equipment, materials, building components, etc., that may be damaged during the course of Contractor work.

### PART 3 – TREATMENT OF PAINTED SURFACES

#### 3.1 LEAD IN CONSTRUCTION REQUIREMENTS

- A. The following is a brief summary of the Lead Exposure in Construction requirements, as per 29 CFR 1926.62.
  - 1. Tasks and Trades Covered By This Rule:
    - a. General Contractors - Commercial, Residential, Highway, Street
    - b. Bridge, Tunnel & Elevated Highway
    - c. Plumbing, Painting, Electrical, Plaster, Drywall & Insulation
    - d. Carpentry
    - e. Floor Layers
    - f. Roofing & Siding
    - g. Structural Steel Erection
    - h. Wrecking & Demolition
    - i. Miscellaneous Special Trades
    - j. Operators of Dwellings
    - k. Operators of State & Municipal Governments

2. Exposure Assessment: The initial step in compliance with this rule shall be to assess exposure to lead of any trade known to be, or suspected of being exposed to lead. The purpose is to determine if any employee is exposed at or above the action level. Employee exposure is that which occurs without the use of respirators. Action Level for Lead Exposure - 30 micrograms per cubic meter of air, Time Weighed Average per 8 hr. shift. Permissible Exposure Level Limit (PEL) - 50 micrograms per cubic meter of air, Time Weighed Average, per 8 hr. shift.
3. Until the exposure assessment is complete, each affected Trade shall be treated as though exposure occurs above the PEL. Personnel samples representative of a full shift shall be collected and include at least one (1) sample for each job classification in each work area for each shift. The results of the exposure assessment will dictate the protection level to be prescribed. Positive and negative indications of exposure should be carefully documented. Additional exposure monitoring shall occur when there is a change in equipment, task, personnel, process, control or any occurrence which may result in additional or further exposure.
4. Employees shall be notified of the results within five (5) working days from the completion of the exposure assessment. Employees found to be exposed at greater levels than the PEL shall be given written notice along with the description of corrective measures to be taken to reduce the exposure to below the PEL.
5. Administrative Controls: If any exposure monitoring results in levels greater than the PEL, the employer shall maintain written programs and make these programs available to employees. Programs shall include: Hazardous Communications (HAZ COM), Respiratory Program in accordance with 29 CFR, Part 1910.134 (b), (d), (e) & (f), Personal Protection Program (including good housekeeping, hygiene facilities and practices, good work practices, etc.) Medical Surveillance, Record Keeping, Training, Medical Removal.
6. Medical Surveillance: Shall include initial blood sampling for lead and zinc protoporphyrin levels. For employees who are, or may be exposed at or above the Action Level for more than 30 days in any consecutive 12 months, biological monitoring with employee notification and medical examination and consultation at least annually shall be implemented.
7. Medical Examination shall include:
  - a. Work History & Medical History (to include past lead exposure).
  - b. Habits: (Smoking & Hygiene)
  - c. Problems with: gastrointestinal, hematologic, renal, cardiovascular, reproductive and neurological problems.
  - d. A thorough physical examination with attention to: teeth, gums, hematologic, gastrointestinal, renal, cardiovascular, and neurological systems.
  - e. Pulmonary Status for respiratory wearers.
  - f. Blood Pressure Measurement
  - g. Hemoglobin & Hematocrit determination, red cell indices, and peripheral smear morphology.

- h. Zinc protoporphyrin
    - i. Blood urea nitrogen
    - j. Serum creatinine
    - k. Routine urinalysis with microscopic examination.
    - l. Any other test relevant to lead exposure deemed necessary by examining physician.
8. Any employee is entitled to, with proper notification to the employer, a second opinion. Should the second examination conducted differ from the first in results, the employee and employer shall negotiate a third opinion. Pregnancy testing and male fertility assessment shall be made available to employees requesting testing.
9. Training shall be on an annual basis, for each employee at or above the action level:
  - a. Content of OSHA Standard
  - b. Nature of Operations
  - c. Description and purpose of Medical Surveillance, Medical Removal Programs
  - d. Health Effects of Exposure (specific to male and female)
  - e. Engineering controls and work practices
  - f. Any other Compliance Plan in Effect
  - g. Chelation
  - h. Respiratory and Personal Protection
  - i. Right to Access of Records
10. Records shall be kept for a period of 30 years. Records are transferred to the new Owner if employee ceases to do business prior to 30 years. If employer discontinues business with no new Owner, prior to 30 years, records are transferred to the Commissioner. Records shall be maintained for the following:
  - a. Exposure Assessment
  - b. Exposure Monitoring
  - c. Respiratory Protection
  - d. Medical Surveillance
  - e. Medical Removals
  - f. Employee Records
11. Records shall be made available for examination and copying to:
  - a. Affected Employees
  - b. Former Employees
  - c. OSHA Assistant Secretary and Director

### 3.2 MINIMUM SAFE WORK PRACTICES REQUIREMENTS

- A. In addition to 29 CFR 1926.62, the Contractor shall implement the minimum safe work practices, as developed by the USEPA and the United States Department of Housing and Urban Development (HUD), which includes and shall apply to coatings that could contain lead and for general construction practices that produce dust, debris, airborne particulates,

etc. Procedures referenced herein also incorporate those of OSHA, N.J.A.C. 5:17 and general industry practices, as applicable, for guidance.

1. Isolate all openings between the exterior work areas and building interiors and/or interior work areas and interior non-work areas, such as windows, doors, HVAC fresh air intakes, etc., with a minimum of two (2) layers of six (6) mil polyethylene sheeting secured airtight with duct tape, and where necessary, spray-glue.
2. Utilize drop cloths, consisting of two (2) layers of six (6) mil polyethylene sheeting within work areas; for exterior work areas, extend the polyethylene sheeting at least five (5) feet from the building's perimeter for exterior related work, to capture any dust, paint chips, debris, etc., generated from the work.
3. Outside work area ingress/egress points, shall have "sticky pads" placed to capture residual dust, including lead dust, from workers footwear/shoes to minimize tracking dust from outside the control area.
4. Treatment Methods for Surfaces Coated with Paint
  - a. Mist surfaces prior to wet scraping in preparation for painting and/or when components are removed for disposal or restoration.
    - i. Lightly mist the component to be removed. Do not apply water to components containing electrical circuits.
    - ii. Using a utility knife or other sharp instrument, carefully score all affected painted seams.
    - iii. Remove any screws or other fasteners.
    - iv. Using a flat pry instrument and a hammer, carefully pry the affected building component away from the surface to which it is attached. The pry bar should be inserted into the seam at the nail or other fastening device at one end of the component and prying pressure applied. This process should be repeated at each subsequent fastening location until the end of the component is reached as the component is freed.
    - v. Carefully remove or bend back all nails (or other fastening devices) and wrap removed components and nails in polyethylene sheeting and seal airtight with high quality spray-glue and duct tape.
    - vi. HEPA vacuum any dust that may have accumulated behind the component removed.
  - b. Preparation for torch cutting of components.
    - i. Perform the limited removal of lead-based paint coatings and primers, at increments of four (4) feet, to facilitate the removal of lead-based paint for the use of cutting torches on bare metal to removal sections of components.
    - ii. The limited paint removal shall expose bare metal, free of all coatings, four (4) inches out from the area to be cut.
    - iii. Limited paint removal shall be accomplished using HEPA vacuum needle guns and/or chemical paint remover.
    - iv. Utilize torches to cut through bare metal for component removal, ensuring that heat from the torch does not impact any adjacent lead-based paint.

- c. Vacuum Water Blasting
  - i. The Contractor shall utilize the equipment in strict conformance with the Manufacturer's specifications.
  - ii. The blast head shall remain in contact with the surface at all times.
  - iii. The Contractor shall implement control measures to capture and/or prevent the migration of water from outside the work area.
  - iv. Waste water generated from the project shall be containerized and undergo a Toxicity Characteristic Leachate Procedure (TCLP) test to determine the method of waste disposal (hazardous versus non-hazardous).
  
- d. Strippable Chemical Solvent
  - i. The chemical stripper shall be troweled, brushed or spray applied. Application thickness of the material shall be determined by the sample test patches.
  - ii. The dwell-time for the paint stripper shall be determined by the evaluation of the sample test patches. Once a proper dwell time is determined, the Contractor shall remove the paint and chemical stripping compound onto the polyethylene ground cover or directly into 55-gallon drums. Any remaining residue shall then be washed down with a detergent and water to reveal the bare surface. Wash down of these surfaces is required to remove any remaining residue left by the chemical stripper. The washdown water shall be contained as specified in Section 4.0. All water and residue shall be removed by using a wet vacuum system.
  - iii. Apply paste type chemical stripper material to the existing painted surfaces by spray application, and simultaneous application of fibrous laminated cloth, where applicable.
  - iv. Remove all spent chemical stripper, fibrous laminated cloth, and old paint from the substrate manually.
  - v. Provide low pressure fresh water rinse for cleaning of the substrate to remove any visible residual of remover and old paint.
  - vi. Special care must be taken to remove chemical stripper materials before they dry or harden, to prevent damaging the surfaces being treated during the removal process. Any tools used shall be made of natural, non-abrasive materials.
  - vii. When utilizing a chemical stripper, the Contractor must determine (by contacting the Manufacturer) if the abated surface must be neutralized prior to subsequent paint application. The Contractor must also determine if neutralization of the surface is required even if the surface will remain unpainted after paint removal.
  - viii. Waste water generated from the project shall be containerized and undergo a Toxicity Characteristic Leachate Procedure (TCLP) test to determine the method of waste disposal (hazardous versus non-hazardous).
  
- e. HEPA Vacuum Needle Gun

- i. Maintain HEPA vacuum attachment in operation during removal operation. Select proper shroud to match the configuration of the surface being treated.
    - ii. The shroud shall remain in contact with the surface at all times.
    - iii. HEPA vacuum needle guns shall only be utilized for metal surfaces.
  - f. Core Penetrations and Drilling
    - i. Maintain HEPA vacuum attachment in operation during the creation of core penetrations and/or drilling through surfaces coated with paint, shellac, varnish, etc. Select proper shroud to match the configuration of the surface being treated and for attachment to the coring/drilling device. The shroud shall remain in contact with the surface at all times.
    - ii. Alternatively, core penetrations/drilling through surfaces shall be via contact through a wet sponge over the surface or viscous foam applied to the surface where the penetrations/drilling shall occur.
    - iii. Sponges utilized for procedures referenced herein shall only be used once per penetration. Viscous foam shall be collected and surfaces where the foam has potentially run along the surface due to gravity or residual shall be wet-wiped clean. All sponges, foam and cloths/rags used for wet-wiping off foam from surfaces shall be included with the waste stream for TCLP testing to determine if the waste is hazardous or non-hazardous.
5. Utilize High Efficiency Particulate Air (HEPA) filter equipped vacuums to clean surfaces at the completion of the require work and to extract dust/debris from polyethylene sheeting used for isolation and/or as drop cloths.
6. Roll polyethylene sheeting drop cloths inward after misting with water prior to disposal.
7. Wet-mop/wipe all horizontal surfaces within proximity to the work area, both inside and outside the building, depending on the work area location, with a trisodium phosphate (TSP) in water solution. Follow the Manufacturer's recommendations for dilution ratio. Prior to and after wet-mopping/wiping, HEPA vacuum all horizontal surfaces, accounting for drying time from wet-mopping/wiping.
8. Utilize personal protection equipment as required by 29 CFR, Part 1926.62. Remove protective clothing on "sticky pads," and have waste bags in proximity to this area to place disposable protective equipment.
9. Coordinate with the Owner and/or Owner's Representative for a restroom that can be dedicated to workers for hygiene purposes, inclusive of washing hands, arms, face, etc., at the completion of each shift. These restrooms shall be HEPA vacuumed, wet-wiped clean and HEPA-vacuumed at the end of each work shift, to remove all visible dust and debris from floors, sinks, urinals, toilets, etc.
10. All disposable items, including mop heads, rags, personal protection equipment, etc., shall be treated as referenced in these Technical Specifications.

### 3.3 MINIMUM NEW JERSEY AIR QUALITY REQUIREMENTS

- A. Where general ventilation is inadequate to control air contaminants emitted from point sources within work spaces to below the Permissible Exposure Limit, such as that outlined above for lead by OSHA, other control measures shall be implemented, such as, but not limited to, negative pressure filtration equipment or an equivalent substitution.
- B. Renovation/demolition work that creates dust and particulates, gases, or other harmful substances in quantities hazardous to health shall be controlled by local ventilation or other protective measures for worker/occupant safety.
- C. Renovation activities in occupied buildings shall be isolated, so as to confine contaminants, dust and debris within the work area. Means of isolation include, but are not limited to, physical barriers (hard construction and/or polyethylene sheeting), work area negative pressure differentials, completing work during minimal periods of occupancy, etc.
- D. Prior to re-occupancy, work areas shall be cleaned and ventilated, as necessary.
- E. Occupants/Trades shall be notified at least 24-hours prior, or promptly for emergencies, of work to be performed on the building that may introduce air contaminants.

### 3.4 WORKER SAFETY

- A. The Contractor is responsible for ensuring all appropriate worker protection regulations are followed, inclusive of those of OSHA, Corporate policies and procedures, the project job site requirements, etc. Project job site requirements shall be provided to the Contractor upon Contract Award, or the day the project commences. Provision herein apply to all Trade related work.
- B. Enforcement of the Contractor's on-site staff to comply with Health and Safety Compliance shall be the sole responsibility of the Contractor's supervisory personnel. The Owner's Representative, the Owner and the Owner's consultants/professional services, shall not be liable for the Contractor's non-compliance with Health and Safety requirements. The exception shall be when the Contractor's actions pose a potential health and safety risk to the Owner and its personnel and/or clients, and/or the Owner's Representative. The exception shall also apply for failure for the Contractor to comply with site rules and regulations. If such a risk occurs, the Owner, Facility and/or Owner's Representative shall Stop Work immediately to rectify the situation.
- C. At a minimum, the Contractor shall ensure the following, which includes provisions within these Technical Specifications.
  - 1. Respiratory Protection Program: Furnish each employee with a half face negative pressure respirator or other appropriate type with a respirator fit test at the time of initial fitting and at least every 12 months thereafter, as required by 29 CFR 1926.62, 29 CFR 1926.103, and 29 CFR 1910.134. Establish and implement a respiratory protection program. Upon completion of the initial employee exposure assessment, adjust respiratory protection as required by 29 CFR 1926.62.

2. Hazard Communication Program: The Contractor shall establish and implement a Hazard Communication Program as required by 29 CFR 1926.59, and 29 CFR 1910.1200.
  3. Change Areas and Shower Facilities: Provide clean change areas within the physical boundary around the designated Lead Control Area. Upon completion of initial employee exposure assessment, adjust requirements in accordance with 29 CFR 1926.62.
  4. Personnel Protection: Personnel shall wear and use protective clothing and equipment, such as respirators, protection suits, eye protection, hard hats, appropriate foot and hand protection, etc. Eating, smoking, or drinking is not permitted in the lead control area. No one will be permitted in the lead control area unless they have been given appropriate training and protective equipment.
  5. It is anticipated that the Contractor will be utilizing power tools. The Contractor shall ensure compliance with the requirements of a hearing protection and conservation, as outlined in 29 CFR 1910.95.
- D. Safety and Health Compliance: In addition to the detailed requirements of this Specification, comply with laws, ordinances, rules and regulations of federal, state and local authorities regarding removing, handling, storing, transporting and disposing of lead waste materials. Comply with applicable requirements of the current issue of 29 CFR 1910.1025. Submit matters regarding interpretation of standards to the owners for resolution before starting work. Where specification requirements and referenced documents vary, the most stringent requirement shall apply.

### 3.5 ADDITIONAL REQUIREMENTS

- A. Construction work shall not generate visible emissions, as required by 40 CFR 61, the National Emissions Standard for Hazardous Air Pollutants (NESHAP).

## PART 4 – WASTE HANDLING AND DISPOSAL

### 4.1 HAZARDOUS WASTE MANAGEMENT PLAN

- A. The Hazardous Waste Management Plan shall comply with applicable requirements of federal, state and local hazardous waste regulations and addresses the following:
  1. Identification of hazardous wastes associated with the work as defined in 40 CFR 261.
  2. Estimated quantities of wastes to be generated and disposed of.
  3. Names and qualifications of each Contractor that will be transporting, storing, treating and disposing of the wastes. Include the facility location and a 24-hour point of contact. Furnish two copies of USEPA, state and local hazardous waste permit applications, permits and USEPA identification numbers.



4. Names and qualifications (experience and training) of personnel who will be responsible for onsite management of hazardous wastes.
5. List of waste handling equipment to be used in performing the work, to include cleaning, volume reduction, and transport equipment.
6. Spill prevention, containment, and clean-up contingency measures to be implemented.
7. Work plan and schedule for waste containment, removal and disposal. Hazardous wastes shall be collected and containerized daily.
8. A locked dumpster or covered truck provided by the Contractor shall be used to store hazardous debris prior to removal at the conclusion of the job.

#### 4.2 WASTE REQUIREMENTS

- A. Waste storage on-site, transportation and disposal shall comply with all applicable waste regulations, which include, but are not limited to, the federal USEPA, DOT and the State of New Jersey waste regulations.
- B. Collect a sample of the lead containing waste to determine if it is at or above the toxicity characteristic limit which classifies the waste as hazardous waste, defined as (5) milligrams per liter (mg/L) lead concentration (USEPA regulation 40 CFR 261.24). TCLP samples shall be analyzed via Test Method 1311 in Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, USEPA publications SW-846.
- C. If the waste classifies as a hazardous waste (i.e., greater than or equal to 5 milligrams per liter of lead concentration), the Contractor shall follow and implement all applicable hazardous waste regulations for the storage, labeling, transportation and disposal of the waste material. This includes, but is not limited to:
  1. Labeling of the hazardous waste containers with the words "hazardous waste" and the waste accumulation date; the waste generator name and address.
  2. The proper completion of the hazardous waste manifest for the off-site shipment.
  3. Storage of the waste materials in USDOT approved containers.
  4. Use of a licensed waste transporter and a treatment, storage and disposal facility (TSDF) authorized to accept the waste.

### PART 5 – OWNER DIRECTED TESTING AND ANALYSIS

#### 5.1 OWNER TESTING OPTIONS

- A. Testing for lead can be conducted by the Owner at any time during the Contractor's activities and may contain but not be limited to air, wipe and soil sampling and analysis.

Samples obtained will be compared to the most stringent Federal, State and Local standards as applicable.

- B. The Contractor shall be responsible for any and all testing and analysis as indicated in the standards noted in this Section. The Owner may, at its discretion, mirror testing and analysis being conducted by the Contractor.
- C. If lead contamination is discovered related to the Contractor's activities, the Contractor shall rectify the contaminant issue by cleaning the area until satisfactory lead wipe or soil results are achieved (per HUD and N.J.A.C. 5:17 clearance criteria) at no additional cost to the Owner. The Contractor shall be responsible for the costs associated with the cleaning in addition to the costs associated with the Owner's Representative.

## 5.2 SAMPLING COMPLIANCE

### A. Post Renovation Clearance Sampling

- 1. At the Owner's discretion, the Owner's Representative may conduct post clearance sampling in accordance with Method SW-846-7000B. All laboratories which analyze samples shall be USEPA recognized, AIHA-LAP, LLC, Environmental Lead Laboratory Accreditation Program (ELLAP) accredited.
- 2. Acceptable clearance sampling results shall be less than the HUD and N.J.A.C. 5:17 clearance criteria as follows:
  - a. Wipe Sample results collected inside the work area shall be less than the following micrograms per square foot ( $\mu\text{g}/\text{sf}^2$ ):
    - i. Floors  $40 \mu\text{g}/\text{sf}^2$
    - ii. Interior Window Sills  $250 \mu\text{g}/\text{sf}^2$
    - iii. Window Troughs  $400 \mu\text{g}/\text{sf}^2$
  - b. Soil Sample taken at the exterior of the work site shall be less than the following micrograms per gram ( $\mu\text{g}/\text{g}$ ):
    - i. Bare Soil  $400 \mu\text{g}/\text{g}$

END OF SECTION

## **SECTION 03 01 30 - MAINTENANCE OF CAST-IN-PLACE CONCRETE**

### **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. Removal of designated portions of concrete and related materials
  - 2. Preparation of substrates and material interfaces to receive repair materials and coatings.
  - 3. Repair material requirements and concrete mixture design
  - 4. Placement of concrete and repair materials
  - 5. Curing & protection of repair and replacement materials.
- B. Related Requirements:
  - 1. Division 03 Section "Cast-In-Place Concrete"

#### **1.3 PRE-INSTALLATION MEETINGS**

- A. Pre-installation Conference: Conduct pre-installation meeting on site prior to installations:
  - 1. Require representatives of each entity directly concerned with concrete to attend, including the following:
    - a. Contractor's superintendent.
    - b. Concrete subcontractor (if applicable).
    - c. Concrete repair material manufacturer's representative.
    - d. Structural Engineer of Record/Design Professional
  - 2. Review methods and procedures related to concrete maintenance including, but not limited to, the following:
    - a. Verify concrete-maintenance specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
    - b. Materials, material application, sequencing, tolerances, and required clearances.
    - c. Quality-control program.

#### **1.4 SUBMITTALS**

- A. General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections, unless otherwise indicated.
- B. Product Data and MSDS: For each type of product indicated.
  - 1. Include construction details, material descriptions, chemical composition, physical properties, test data, and mixing, preparation, and application instructions.
- C. Material Certificates: For each of the following, signed by manufacturers:
  - 1. Repair materials
  - 2. Steel reinforcement, protective coatings and accessories.
  - 3. Bonding agents.
  - 4. Adhesives.
- D. Product Test Reports: For each manufactured bonding agent and cementitious repair mortar for tests performed by manufacturer and witnessed by a qualified testing agency.

- E. For cementitious concrete repair materials submit manufacturer's data sheet consistent with the requirements of ACI 364.3R-09.
- F. Submit mix designs for concrete, associated laboratory test reports and product data for admixtures. Include additional mix proportion tests for characteristics of materials that may be varied for special project conditions, weather, or other circumstances. As a performance-based system, mix design responsibility rests with the concrete supplier.
- G. Submit name of qualified independent testing laboratory for mix design preparation and laboratory test reports for evaluation of concrete materials and mix design.
- H. Field quality-control reports.
- I. Quality-Control Program: Submit before work begins.
- J. Submit any plans or other documents, needed to complete the work, prepared by specialty engineer.

## **1.5 QUALITY ASSURANCE**

- A. Concrete Standards: Comply with provisions of the following standards and industry practice guidelines, except where more stringent requirements are indicated.
  - 1. ACI Manual of Concrete Practice, including the following standards:
    - a. ACI 301, "Specifications for Structural Concrete for Buildings".
    - b. ACI 318, "Building Code Requirements for Structural Concrete."
    - c. ACI 562, "Code Requirements for Evaluation, Repair, and Rehabilitation of Concrete Buildings".
  - 2. Concrete Reinforcing Steel Institute (CRSI) "Manual of Standard Practice".
  - 3. International Concrete Repair Institute (ICRI): Technical Guidelines
- B. Manufacturing Qualifications: The manufacturer of the specified product shall be ISO 9001 certified and have in existence a recognized ongoing quality assurance program independently audited on a regular basis.
- C. Contractor Qualifications: Engage an experienced concrete-maintenance firm that employs installers and supervisors who are trained and approved by manufacturer to apply specified materials to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing or patching new concrete is insufficient experience for concrete-maintenance work.
  - 1. Supervision: Concrete-maintenance specialist firm shall maintain experienced full-time supervisors on Project site during times that concrete-maintenance work is in progress.
- D. Quality-Control Program: Prepare a written plan for concrete maintenance to systematically demonstrate the ability of personnel to properly perform maintenance work, including each phase or process, protection of surrounding materials during operations, and control of debris and runoff during the Work. Describe in detail materials, methods, equipment, and sequence of operations to be used for each phase of the Work
- E. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
  - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

## **1.6 DELIVERY, STORAGE AND HANDLING**

- A. All material must be delivered in original, unopened containers with the manufacturer's name, labels, product identification, and batch numbers. Damaged material must be removed from the site immediately.
- B. Store all materials off the ground and protect from rain, freezing, or excessive heat until ready for use.

## **1.7 PROJECT CONDITIONS**

- A. Cold-Weather Requirements for Cementitious Materials: Do not install material if weather conditions will adversely impact installation, except where approved protective measures are in place. Maintain minimum application temperature 45°F and rising or provide temporary climate control measures in accordance with manufacturer requirements.
- B. Hot-Weather Requirements for Cementitious Materials: Protect repair work when temperature and humidity conditions produce excessive evaporation of water from patching materials. Provide artificial shade and wind breaks, and use cooled materials as required. Do not apply to substrates with temperatures of 90°F and above.
- C. Take precautions to avoid damage to any surface near the work zone due to operations, mixing, handling and/or placing of materials.

## **1.8 WARRANTY**

- A. Provide written contractor warranties in compliance with contract requirements.
- B. Provide written manufacturers warranties for all materials for maximum manufacturer warranty period available.

## **PART 2 - PRODUCTS**

### **2.1 REPAIR MATERIAL MANUFACTURERS**

- A. Repair Materials
  1. BASF Corporation, Shakopee, MN 55379
  2. Sika Corporation, Lyndhurst, NJ 07071
  3. Mapei Corporation, Deerfield Beach, FL 33442
  4. Or approved equivalent.
- B. 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, or approved equivalents.
  2. 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, or approved equivalents.

### **2.2 FORM-FACING MATERIALS**

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
  1. Plywood, metal, or other approved panel materials.

2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
  - a. High-density overlay, Class 1 or better.
  - b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
  - c. Structural 1, B-B or better; mill oiled and edge sealed.
  - d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.
- B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
- D. Formulate form-release agent with rust inhibitor for steel form-facing materials.

### **2.3 STEEL REINFORCEMENT**

- A. Uncoated Reinforcing Steel Bars: ASTM A 615, Grade 60, deformed.
- B. Uncoated Reinforcing Steel Bars (weldable): ASTM A 706, Grade 60, deformed.

### **2.4 REINFORCEMENT ACCESSORIES**

- A. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
  1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

### **2.5 CONCRETE MATERIALS**

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project.
- B. Portland Cement: ASTM C 150, Type I, low-alkali, gray. Supplement with the following:
  1. Fly Ash: ASTM C 618, Class F, or
  2. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120, or
  3. Supplementary cementitious materials to be added in accordance with requirements of ACI 318, or
  4. Silica Fume: ASTM C 1240, amorphous silica.
- C. Normal-Weight Aggregates: ASTM C 33, coarse aggregate or better, graded. Provide aggregates from a single source.
  1. Maximum Coarse-Aggregate Size: 3/8" to No. 8, except where larger diameter aggregates can be accommodated in forms. Free of materials with deleterious reactivity to alkali in cement.
  2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Water: ASTM C 94.

### **2.6 ADMIXTURES**

- A. Air-Entraining Admixture: ASTM C 260.

1. Entrained air content 6% +/- 1.5%.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
  1. Water-Reducing Admixture: ASTM C 494, Type A.
  2. High-Range, Water-Reducing Admixture: ASTM C 494, Type F.
  3. Plasticizing and Retarding Admixture: ASTM C 1017, Type II.
  4. Corrosion Inhibitor – Calcium Nitrite Based.
- C. Minimum dosage 3 gallons per cubic yard in ready-mix concrete.

## **2.7 CURING MATERIALS**

- A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

## **2.8 CONCRETE REPAIR MATERIALS**

- A. Concrete Patching and Repairs:
  1. BASF MasterEmaco N 400 RS, or approved equivalent (vertical and overhead repairs only)
  2. Sika SikaQuick VOH, or approved equivalent (vertical and overhead repairs only)
  3. Contractor to verify that any corrosion inhibiting admixtures are not calcium nitrite based.
  4. Contractor to submit a non-shrink grout material for approval by Design Professional. Non-shrink grout shall be non-chloride containing.
  5. Other materials shall be pre-approved by Design Professional – see section 1.3D.
- B. Anti-Corrosion Reinforcing Steel Coating
  1. Mapei Mepefer 1k, or approved equivalent
  2. Alternate materials shall be approved by Design Professional. Materials shall be cementitious in nature, high pH, or shall provide a sacrificial galvanic material.

## **2.9 CONCRETE REPAIR MATERIAL PROPERTIES**

- A. Minimum requirements for concrete repair materials are listed below. Provide test results in accordance with requirements of ACI 364.3R-09.
- B. Compressive strength – ASTM C 39
  1. Minimum - 4,000 psi at 28 days
- C. Modulus of elasticity - ASTM C469
  1. Minimum –  $3.5 \times 10^6$  psi at 28 days
- D. Coefficient of thermal expansion - CRD-C 39
  1. Maximum value – 6.5 millionths / deg. F
- E. Freeze-thaw resistance – ASTM C666
  1. Procedure A – Durability factor greater > 97% at 300 cycles

- F. Unrestrained drying shrinkage – ASTM C157 modified per procedure ASTM C928
  - 1. Maximum expansion – 1,000 microstrain storage in air or water
  - 2. Maximum shrinkage – 600 microstrain storage in air or water
- G. Restrained drying shrinkage – ASTM C1581
  - 1. No cracking within 14 days – storage in air.
  - 2. Average stress rate (s) < 20 psi/day

## **2.10 MISCELLANEOUS MATERIALS**

- A. Structural Adhesive: For new reinforcement / anchors installed into existing concrete.
  - 1. Hilti-HIT HY 200 Adhesive Anchoring System with Safe-Set Technology, or approved equivalent.
- B. Pins: For repairs indicated on Drawings.
  - 1. Threaded Rod, AISI Type 304 Stainless Steel
    - a. Size / Length: As indicated on Drawings

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Notify Design Professional seven days in advance of dates when areas of deteriorated or delaminated concrete and deteriorated reinforcing bars will be located.
- B. Locate areas of deteriorated or delaminated concrete using hammer or chain-drag sounding and mark boundaries. Mark areas for removal by simplifying and squaring off boundaries. At columns and walls make boundaries level and plumb unless otherwise indicated
- C. Document concrete repair locations as work progresses.

### **3.2 PREPARATION**

- A. Ensure that supervisory personnel are on-site and on duty when concrete maintenance work begins and during its progress.
- B. Protect persons, motor vehicles, surrounding surfaces of building being repaired, building site, and surrounding buildings from harm resulting from concrete repair work.
- C. Preparation for Concrete Removal: Examine construction to be repaired to determine best methods to safely and effectively perform concrete maintenance work. Examine adjacent work to determine what protective measures will be necessary. Make explorations, probes, and inquiries as necessary to determine condition of construction to be removed in the course of repair.
  - 1. Verify that affected utilities have been disconnected and capped.
  - 2. Inventory and record the condition of items to be removed for reinstallation or salvage.
  - 3. Provide and maintain shoring, bracing, and temporary structural supports as required to preserve stability and prevent unexpected or uncontrolled movement, settlement, or collapse of construction being demolished and construction and finishes to remain. Strengthen or add new supports when required during progress of removal work.

### **3.3 SELECTIVE REMOVALS**

- A. Do not overload structural elements with debris.



- B. Selectively demolish and remove existing concrete only to the extent required by new construction and as indicated. Use methods required to complete Work within limitations of governing regulations and as follows:
1. Proceed with selective removals systematically as detailed in the project schedule.
  2. Mechanically prepare the concrete substrate to obtain a surface profile of +/- 1/8" (CSP 5 or greater as per ICRI Guidelines) with a new exposed aggregate surface. Minimum depth of repair area shall be 3/4" in depth.
  3. Provide straight, even sawcut edges around all removal areas being sure to not disturb post-tensioning reinforcing or damage any embedded steel reinforcing that is to remain.
  4. Perform concrete removal in areas to be repaired using saw cutting equipment, suitable chipping hammers (15 lb limit), scabblers and other equipment, that minimizes bruising of the finish substrate layer.
    - a. Perform abrasive blasting with sand, water or other media as a final preparation step to remove layers with bruising damage.
  5. Do not cut, damage or remove existing embedded reinforcing steel, electrical conduits, etc., unless directed by the Design Professional.
  6. If unanticipated mechanical, electrical, or structural elements that conflict with intended function or design are encountered, investigate and measure both nature and extent of the conflict. Submit report in writing to Design Professional with accurate detail of conflict. Pending receipt of directive from Design Professional, rearrange selective removals schedule as necessary to continue overall job progress without undue delay.
- C. EMBEDDED REINFORCING STEEL
1. Reinforcing steel with more than 50% of surface area exposed, or has been bond degradation due to cracking or corrosion shall be undercut to provide 3/4 inch of clear space around reinforcing steel.
  2. Reinforcing steel in columns or structural elements in compression shall only be undercut when directed by Design Professional.
  3. Exposed reinforcing steel that is adhered to substrate with no evidence of bond degradation can remain in place without being undercut.
  4. Where mild reinforcing steel with corrosion is encountered, sandblast or mechanically clean the steel to remove all contaminants and rust. Where existing reinforcing is epoxy coated, mechanically remove the coating in areas where corrosion is present, as well as in areas where the coating is damaged or de-bonded. Extend removal to sound coating region.
  5. Undercutting of reinforcing steel shall extend until reinforcing steel with no corrosion product is found.
  6. Apply approved reinforcing steel coating to completely encapsulate areas of exposed reinforcing steel.
  7. All vertical and overhead repair areas shall have undercut reinforcing steel present or embedded pins shall be installed in the repair area. Embedded pins to be a minimum of 3 inches long, embedded in epoxy to a minimum depth of 1.5 inches. Pins to have a minimum diameter of 3/8 inch. Pins to be constructed from stainless steel. Maximum pin spacing to be 18 inches on center, with a minimum of one pin per repair area.
- D. EVALUATION OF EXPOSED SURFACES AND REINFORCEMENT
1. After removals are complete, but prior to final cleaning & coating, all exposed concrete surfaces and all reinforcement designated to remain in place will be reviewed by the Design Professional or designated representative. When unsatisfactory surface preparation is observed, perform additional removals and preparation until satisfactory conditions are achieved and approved by Design Professional or designated representative.
  2. Contractor shall provide minimum of 48 hours notice to Design Professional prior to inspection.
- E. LOSS OF SECTION DUE TO CORROSION

1. Reinforcing steel with greater than 25% loss of cross-section area due to corrosion shall be supplemented with new reinforcing steel.
2. Design Professional may waive requirement to supplement reinforcing steel.
3. Supplemental reinforcing steel shall be installed with sufficient lap length to allow sufficient for development of the new reinforcing steel to replace the cross-section lost to corrosion.
4. Supplemental reinforcing steel to have similar mechanism for corrosion mitigation as existing reinforcing steel.

### **3.4 FORMWORK**

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
  1. Class A, 1/8 inch for smooth-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces.
- F. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- G. Chamfer exterior corners and edges of permanently exposed concrete.
- H. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- I. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- J. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### **3.5 EMBEDDED ITEMS**

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

### **3.6 REMOVING AND REUSING FORMS**

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.

1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 75 percent of its 28-day design compressive strength.
  2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Design Professional.

### **3.7 SHORES AND RESHORES**

- A. Comply with ACI 562 and ACI 301 for design, installation, and removal of shoring and reshoring.
- B. When required by Design Professional, contractor shall retain a specialty engineer to design required shoring members. Shoring plans developed by specialty engineer shall be signed and sealed.
- C. In multistory construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
- D. Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

### **3.8 STEEL REINFORCEMENT**

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.

### **3.9 MIXING AND APPLICATION**

- A. Concrete & repair materials:
1. Deposit concrete material continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. Deposit concrete to avoid segregation.
    - a. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
    - b. Consolidate placed concrete with mechanical vibrating equipment
  2. Mix and place pre-packaged concrete material in accordance with manufacturer directions.
    - a. For vertical and overhead applications, trowel apply in lifts in accordance with manufacturer instructions.
- B. Finishing
1. Broom or trowel finish to match existing conditions. Provide transverse broom finish perpendicular to anticipated flow of traffic
  2. Repair and patch tie holes and defects in formed surfaces, removing fins and other projections or irregularities.
  3. Cure patching per manufacturers written directions. Contractor shall be required to submit curing plan procedures for Design Professional approval prior to placement of patching material.

4. Remove all form work when the concrete repair has reached a minimum of 3,000 psi. Repair all bug holes and fastener holes upon removal of form.

### **3.10 CONCRETE PROTECTING AND CURING**

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 for hot-weather protection during curing.
- B. Formed Surfaces: If removing forms before end of curing period, continue curing for the remainder of the curing period.
- C. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- D. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
  1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

### **3.11 CLEAN UP**

- A. Clean all work areas of all wet and/or dried concrete material and sealant on a daily basis.
- B. Leave finished work and work area in a neat, clean condition without evidence of spillovers onto adjacent areas.

### **3.12 FIELD QUALITY CONTROL**

- A. Testing and Inspecting: The Design Professional will perform inspections unless otherwise indicated. Where discrepancies arise, contractor shall engage a qualified testing agency to perform tests and to submit reports.
- B. The Design Professional reserves the right to waive the requirements of any of the required inspections/testing.
- C. Observations:
  1. Removals and surface preparations
  2. Steel reinforcement repairs & protections; placement.
  3. Concrete placement & finishing
  4. Curing procedures and maintenance of curing temperature.
- D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
  1. Testing Frequency: Obtain one composite sample for each day's placement of each concrete mixture.
  2. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  3. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
  4. Compression Test Specimens: ASTM C 31.
    - a. 2 samples, laboratory cured, test at 28 days.

- b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.

**3.13 PERFORMANCE OF SURFACE REPAIRS**

- A. Failure of concrete patches to bond to substrate (as evidenced by a hollow sound when tapped), excessive shrinkage, or disintegration or other failure of patches to perform, will be considered failure of materials and workmanship. Repair or replace all defective areas of such failures as directed by Design Professional.

**END OF SECTION 03 01 30**

## **SECTION 03 30 00 - CAST-IN-PLACE CONCRETE**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Related Requirements:
  - 1. Division 07 Section "Fluid-Applied Membrane Air Barriers" for preparation of concrete surfaces to receive air barrier material.
  - 2. Division 31 Sections for drainage fill under slabs-on-grade.
  - 3. Division 32 Section "Concrete Paving" for concrete pavement and walks.

#### **1.3 DEFINITIONS**

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash, slag cement, other pozzolans, and silica fume; materials subject to compliance with requirements.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

#### **1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
    - a. Contractor's superintendent.
    - b. Independent testing agency responsible for concrete design mixtures.
    - c. Ready-mix concrete manufacturer.
    - d. Concrete Subcontractor.
    - e. Special concrete finish Subcontractor.
  - 2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, floor and slab flatness and levelness measurement, concrete repair procedures, and concrete protection.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
  - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.

- C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement.
- D. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
  - 1. Location of construction joints is subject to approval of the Architect.
- E. Samples: For waterstops and vapor retarder.

#### 1.6 **INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer, manufacturer and testing agency.
- B. Welding certificates.
- C. Material Certificates: For each of the following, signed by manufacturers:
  - 1. Cementitious materials.
  - 2. Admixtures.
  - 3. Form materials and form-release agents.
  - 4. Steel reinforcement and accessories.
  - 5. Waterstops.
  - 6. Curing compounds.
  - 7. Floor and slab treatments.
  - 8. Bonding agents.
  - 9. Adhesives.
  - 10. Vapor retarders.
  - 11. Semirigid joint filler.
  - 12. Joint-filler strips.
- D. Material Test Reports: For the following, from a qualified testing agency:
  - 1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- E. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.
- F. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.
- G. Field quality-control reports.
- H. Minutes of preinstallation conference.

#### 1.7 **QUALITY ASSURANCE**

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.
  - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

- C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
  - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
  - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician, Grade II.
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M.
- E. Products in this section may be required in free-standing mockups.

#### 1.8 **PRECONSTRUCTION TESTING**

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

#### 1.9 **DELIVERY, STORAGE, AND HANDLING**

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.
- B. Waterstops: Store waterstops under cover to protect from moisture, sunlight, dirt, oil, and other contaminants.

#### 1.10 **FIELD CONDITIONS**

- A. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
  - 1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
  - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
  - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- B. Hot-Weather Placement: Comply with ACI 301 and ACI 305.1, and as follows:
  - 1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  - 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

### **PART 2 - PRODUCTS**

#### 2.1 **CONCRETE, GENERAL**

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
  - 1. ACI 301.
  - 2. ACI 117.



## 2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
  - 1. Plywood, metal, or other approved panel materials.
  - 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
    - a. High-density overlay, Class 1 or better.
    - b. Medium-density overlay, Class 1 or better; mill-release agent treated and edge sealed.
    - c. Structural 1, B-B or better; mill oiled and edge sealed.
    - d. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Pan-Type Forms: Glass-fiber-reinforced plastic or formed steel, stiffened to resist plastic concrete loads without detrimental deformation.
- D. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- E. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch, minimum.
- F. Rustication Strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.
- G. Form-Release Agent: Commercially formulated form-release agent that does not bond with, stain, or adversely affect concrete surfaces and does not impair subsequent treatments of concrete surfaces.
  - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- H. Form Ties: Factory-fabricated, removable or snap-off glass-fiber-reinforced plastic or metal form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
  - 1. Furnish units that leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
  - 2. Furnish ties that, when removed, leave holes no larger than 1 inch in diameter in concrete surface.
  - 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.

## 2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
- B. Epoxy-Coated Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed bars, ASTM A775/A775M or ASTM A934/A934M, epoxy coated, with less than 2 percent damaged coating in each 12-inch bar length.
- C. Steel Bar Mats: ASTM A184/A184M, fabricated from ASTM A615/A615M, Grade 60 ASTM A706/A706M, deformed bars, assembled with clips.
- D. Deformed-Steel Wire: ASTM A1064/A1064M.
- E. Plain-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, plain, fabricated from as-drawn steel wire into flat sheets.
- F. Deformed-Steel Welded-Wire Reinforcement: ASTM A1064/A1064M, flat sheet.

- G. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A coated, Type 1, plain steel.

## 2.4 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, cut true to length with ends square and free of burrs.
- B. Epoxy-Coated Joint Dowel Bars: ASTM A615/A615M, Grade 60, plain-steel bars, ASTM A775/A775M epoxy coated.
- C. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating; compatible with epoxy coating on reinforcement and complying with ASTM A775/A775M.
- D. Zinc Repair Material: ASTM A780/A780M.
- E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
  - 1. For concrete surfaces exposed to view, where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.
  - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
  - 3. For zinc-coated reinforcement, use galvanized wire or dielectric-polymer-coated wire bar supports.

## 2.5 CONCRETE MATERIALS

- A. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from single source, and obtain admixtures from single source from single manufacturer.
- B. Cementitious Materials:
  - 1. Portland Cement: ASTM C150/C150M, Type I or Type II.
  - 2. Fly Ash: ASTM C618, Class F or C.
  - 3. Slag Cement: ASTM C989/C989M, Grade 100 or 120.
- C. Normal-Weight Aggregates: ASTM C33/C33M, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source with documented service record data of at least 10 years' satisfactory service in similar applications and service conditions using similar aggregates and cementitious materials.
  - 1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
  - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Lightweight Aggregate: ASTM C330/C330M, 3/4-inch nominal maximum aggregate size.
- E. Air-Entraining Admixture: ASTM C260/C260M.
- F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
  - 1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
  - 2. Retarding Admixture: ASTM C494/C494M, Type B.
  - 3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
  - 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
  - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.

6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
- G. Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete and complying with ASTM C494/C494M, Type C.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. BASF Corporation.
    - b. Euclid Chemical Company (The); an RPM company.
    - c. GCP Applied Technologies Inc.
    - d. Sika Corporation.
    - e. Or approved equivalent.
- H. Non-Set-Accelerating Corrosion-Inhibiting Admixture: Commercially formulated, non-set-accelerating, anodic inhibitor or mixed cathodic and anodic inhibitor; capable of forming a protective barrier and minimizing chloride reactions with steel reinforcement in concrete.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. BASF Corporation.
    - b. Cortec Corporation.
    - c. GCP Applied Technologies Inc.
    - d. Sika Corporation.
    - e. Or approved equivalent.
- I. Water: ASTM C94/C94M.

## 2.6 WATERSTOPS

- A. Flexible Rubber Waterstops: CE CRD-C 513, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Williams Products, Inc.
    - b. Or approved equivalent.
  2. Profile: Flat dumbbell with center bulb
  3. Dimensions: 6 inches by 3/8 inch thick; nontapered.
- B. Flexible PVC Waterstops: CE CRD-C 572, with factory-installed metal eyelets, for embedding in concrete to prevent passage of fluids through joints. Factory fabricate corners, intersections, and directional changes.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. BoMetals, Inc.
    - b. Sika Corporation.
    - c. Vinylex Waterstop & Accessories.
    - d. Or approved equivalent.
  2. Profile: Flat dumbbell with center bulb.
  3. Dimensions: 6 inches by 3/8 inch thick; nontapered.
- C. Self-Expanding Butyl Strip Waterstops: Manufactured rectangular or trapezoidal strip, butyl rubber with sodium bentonite or other hydrophilic polymers, for adhesive bonding to concrete, 3/4 by 1 inch.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Carlisle Coatings & Waterproofing Inc.
  - b. CETCO, a Minerals Technologies company.
  - c. Concrete Sealants Inc.
  - d. Henry Company.
  - e. JP Specialties, Inc.
  - f. Sika Corporation.
  - g. Or approved equivalent.

## 2.7 VAPOR RETARDERS

- A. Sheet Vapor Retarder: ASTM E1745, Class A. Include manufacturer's recommended adhesive or pressure-sensitive tape.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Barrier-Bac; Inteplast Group.
    - b. Fortifiber Building Systems Group.
    - c. ISI Building Products.
    - d. Poly-America, L.P.
    - e. Raven Industries, Inc.
    - f. Reef Industries, Inc.
    - g. Stego Industries, LLC.
    - h. Tex-Trude.
    - i. W.R. Meadows, Inc.
    - j. Or approved equivalent.

## 2.8 CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. BASF Corporation.
    - b. ChemMasters, Inc.
    - c. Dayton Superior.
    - d. Euclid Chemical Company (The); an RPM company.
    - e. Kaufman Products, Inc.
    - f. Lambert Corporation.
    - g. Laticrete International, Inc.
    - h. Sika Corporation.
    - i. W.R. Meadows, Inc.
    - j. Or approved equivalent.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, nondissipating, certified by curing compound manufacturer to not interfere with bonding of floor covering.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. BASF Corporation.
  - b. ChemMasters, Inc.
  - c. Dayton Superior.
  - d. Euclid Chemical Company (The); an RPM company.
  - e. Kaufman Products, Inc.
  - f. Lambert Corporation.
  - g. Laticrete International, Inc.
  - h. W.R. Meadows, Inc.
  - i. Or approved equivalent.

## 2.9 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D1751, asphalt-saturated cellulosic fiber or ASTM D1752, cork or self-expanding cork.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, epoxy resin with a Type A shore durometer hardness of 80, aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 according to ASTM D2240.
- C. Bonding Agent: ASTM C1059/C1059M, Type II, nonredispersible, acrylic emulsion or styrene butadiene.
- D. Epoxy Bonding Adhesive: ASTM C881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to suit requirements, and as follows:
  1. Types IV and V, load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.
- E. Reglets: Fabricate reglets of not less than 0.022-inch-thick, galvanized-steel sheet. Temporarily fill or cover face opening of reglet to prevent intrusion of concrete or debris.
- F. Dovetail Anchor Slots: Hot-dip galvanized-steel sheet, not less than 0.034 inch thick, with bent tab anchors. Temporarily fill or cover face opening of slots to prevent intrusion of concrete or debris.
- G. Steel Embed Plates: Refer to Structural Drawings for additional information.

## 2.10 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
  1. Cement Binder: ASTM C150/C150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
  2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.
  4. Compressive Strength: Not less than 4000 psi at 28 days when tested according to ASTM C109/C109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch and that can be filled in over a scarified surface to match adjacent floor elevations.

1. Cement Binder: ASTM C150/C150M, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C219.
2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by topping manufacturer.
4. Compressive Strength: Not less than 5000 psi at 28 days when tested according to ASTM C109/C109M.

## 2.11 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
  1. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
  1. Fly Ash: 25 percent.
  2. Combined Fly Ash and Pozzolan: 25 percent.
  3. Slag Cement: 50 percent.
  4. Combined Fly Ash or Pozzolan and Slag Cement: 50 percent portland cement minimum, with fly ash or pozzolan not exceeding 25 percent.
  5. Silica Fume: 10 percent.
  6. Combined Fly Ash, Pozzolans, and Silica Fume: 35 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
  7. Combined Fly Ash or Pozzolans, Slag Cement, and Silica Fume: 50 percent with fly ash or pozzolans not exceeding 25 percent and silica fume not exceeding 10 percent.
- C. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent by weight of cement.
- D. Admixtures: Use admixtures according to manufacturer's written instructions.
  1. Use water-reducing, high-range water-reducing or plasticizing admixture in concrete, as required, for placement and workability.
  2. Use water-reducing and -retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
  3. Use water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a w/c ratio below 0.50.
  4. Use corrosion-inhibiting admixture in concrete mixtures where indicated.

## 2.12 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Footings, Foundations, Building Walls and Exterior Equipment Pads: Normal-weight concrete.
  1. Minimum Compressive Strength: 5000 psi at 28 days.
  2. Maximum W/C Ratio: 0.45.
  3. Slump Limit: 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
  4. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 3/4-inch nominal maximum aggregate size.
- B. Slabs on Grade, Mat Slabs, Interior Equipment Pads: Normal-weight concrete.
  1. Minimum Compressive Strength: 4000 psi at 28 days.
  2. Maximum W/C Ratio: 0.45.
  3. Minimum Cementitious Materials Content: 540 lb/cu. yd.

4. Slump Limit: 4 inches, plus or minus 1 inch.
5. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

C. Suspended Slabs: Lightweight concrete.

1. Minimum Compressive Strength: 4000 psi at 28 days.
2. Calculated Equilibrium Unit Weight: 115 lb/cu., plus or minus 3 lb/cu. ft. as determined by ASTM C567/C567M.
3. Slump Limit: 4 inches, plus or minus 1 inch.
4. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.

## 2.13 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

## 2.14 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C94/C94M, and furnish batch ticket information.

1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

- B. Project-Site Mixing: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M. Mix concrete materials in appropriate drum-type batch machine mixer.

1. For mixer capacity of 1 cu. yd. or smaller, continue mixing at least 1-1/2 minutes, but not more than 5 minutes after ingredients are in mixer, before any part of batch is released.
2. For mixer capacity larger than 1 cu. yd., increase mixing time by 15 seconds for each additional 1 cu. yd..
3. Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mixture type, mixture time, quantity, and amount of water added. Record approximate location of final deposit in structure.

## PART 3 - EXECUTION

### 3.1 FORMWORK INSTALLATION

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.

- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.

- C. Limit concrete surface irregularities, designated by ACI 347 as abrupt or gradual, as follows:

1. Class A, 1/8 inch for smooth-formed finished surfaces.
2. Class C, 1/2 inch for rough-formed finished surfaces.

- D. Construct forms tight enough to prevent loss of concrete mortar.

- E. Construct forms for easy removal without hammering or prying against concrete surfaces.

Provide crush or wrecking plates where stripping may damage cast-concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.

1. Install keyways, reglets, recesses, and the like, for easy removal.
2. Do not use rust-stained steel form-facing material.

- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.

- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.
- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

### 3.2 **EMBEDDED ITEM INSTALLATION**

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC 303.
  2. Install reglets to receive waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
  3. Install dovetail anchor slots in concrete structures as indicated.

### 3.3 **REMOVING AND REUSING FORMS**

- A. General: Formwork for sides of walls, piers, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete. Concrete has to be hard enough to not be damaged by form-removal operations, and curing and protection operations need to be maintained.
  1. Leave formwork for slabs, and other structural elements that support weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
  2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material are not acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

### 3.4 **SHORING AND RESHORING INSTALLATION**

- A. Comply with ACI 318 and ACI 301 for design, installation, and removal of shoring and reshoring.
  1. Do not remove shoring or reshoring until measurement of slab tolerances is complete.



### 3.5 VAPOR-RETARDER INSTALLATION

- A. Sheet Vapor Retarders: Place, protect, and repair sheet vapor retarder according to ASTM E1643 and manufacturer's written instructions.
  - 1. Lap joints 6 inches and seal with manufacturer's recommended tape.
- B. Bituminous Vapor Retarders: Place, protect, and repair bituminous vapor retarder according to manufacturer's written instructions.

### 3.6 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
  - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not tack weld crossing reinforcing bars.
  - 1. Weld reinforcing bars according to AWS D1.4/D 1.4M, where indicated.
- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded-wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.
- F. Epoxy-Coated Reinforcement: Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963/D3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

### 3.7 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
  - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
  - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
  - 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
  - 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
  - 5. Space vertical joints in walls at maximum 40'-0". Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
  - 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  - 7. Use epoxy-bonding adhesive at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.

- C. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness as follows:
  - 1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint to a radius of 1/8 inch. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover tool marks on concrete surfaces.
  - 2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch-wide joints into concrete when cutting action does not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks.
  
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
  - 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.
  - 2. Terminate full-width joint-filler strips not less than 1/2 inch or more than 1 inch below finished concrete surface where joint sealants, specified in Section 079200 "Joint Sealants," are indicated.
  - 3. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.

### 3.8 WATERSTOP INSTALLATION

- A. Flexible Waterstops: Install in construction joints and at other joints indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of the Work. Field fabricate joints in waterstops according to manufacturer's written instructions.
  
- B. Self-Expanding Strip Waterstops: Install in construction joints and at other locations indicated, according to manufacturer's written instructions, adhesive bonding, mechanically fastening, and firmly pressing into place. Install in longest lengths practicable.

### 3.9 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.
  
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect.
  
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
  - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
  
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
  - 1. Deposit concrete in horizontal layers of depth not to exceed formwork design pressures and in a manner to avoid inclined construction joints.
  - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
  - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations 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 lose plasticity. At each insertion, limit duration of vibration to time necessary to

consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.

- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.
  - 1. Consolidate concrete during placement operations, so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
  - 2. Maintain reinforcement in position on chairs during concrete placement.
  - 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
  - 4. Slope surfaces uniformly to drains where required.
  - 5. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.

### 3.10 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  - 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  - 1. Apply to concrete surfaces exposed to public view or to be covered with a coating or covering material applied directly to concrete.
- C. 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. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

### 3.11 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. Scratch Finish: While still plastic, texture concrete surface that has been screeded and bull-floated or darbied. Use stiff brushes, brooms, or rakes to produce a profile amplitude of 1/4 inch in one direction.
  - 1. Apply scratch finish to surfaces to receive mortar setting beds for bonded cementitious floor finishes.
- C. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power-driven floats. Restraighten, cut down high spots, and fill low spots. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
  - 1. Apply float finish to surfaces to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- D. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
  - 1. Apply a trowel finish to surfaces to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.

2. Finish surfaces to the following tolerances, according to ASTM E1155, for a randomly trafficked floor surface:
    - a. Specified overall values of flatness, F(F) 25; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 17; and of levelness, F(L) 15 for slabs on grade.
    - b. Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for suspended slabs.
  3. Finish and measure surface, so gap at any point between concrete surface and an unlevelled, freestanding, 10-ft.- long straightedge resting on two high spots and placed anywhere on the surface does not exceed 1/8 inch.
- E. Trowel and Fine-Broom Finish: Apply a first trowel finish to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset method. While concrete is still plastic, slightly scarify surface with a fine broom.
1. Comply with flatness and levelness tolerances for trowel-finished floor surfaces.
- F. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps, and elsewhere as indicated.
1. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Architect before application.

### 3.12 MISCELLANEOUS CONCRETE ITEM INSTALLATION

- A. Filling In: Fill in holes and openings left in concrete structures after work of other trades is in place unless otherwise indicated. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the 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:
1. Coordinate sizes and locations of concrete bases with actual equipment provided.
  2. Construct concrete bases minimum 4 inches high unless otherwise indicated, and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
  3. Minimum Compressive Strength: 5000 psi at 28 days.
  4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete substrate.
  6. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  7. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.

### 3.13 CONCRETE PROTECTING AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 305.1 for hot-weather protection during curing.

- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for remainder of curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by one or a combination of the following methods:
  - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.
  - 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
    - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
    - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
    - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies does not interfere with bonding of floor covering used on Project.
  - 3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
    - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound does not interfere with bonding of floor covering used on Project.
  - 4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

### 3.14 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
  - 1. Defer joint filling until concrete has aged at least one month(s). Do not fill joints until construction traffic has permanently ceased.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joints clean and dry.

- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

### 3.15 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
  - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area 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.
  - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
  - 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  - 2. After concrete has cured at least 14 days, correct high areas by grinding.
  - 3. Correct localized low areas 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.
  - 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
  - 5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  - 6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
  - 7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place

patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.

- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

### 3.16 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing Agency: Engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports.
- C. Inspections:
  - 1. Steel reinforcement placement.
  - 2. Steel reinforcement welding.
  - 3. Headed bolts and studs.
  - 4. Verification of use of required design mixture.
  - 5. Concrete placement, including conveying and depositing.
  - 6. Curing procedures and maintenance of curing temperature.
- D. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:
  - 1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd., but less than 25 cu. yd., plus one set for each additional 50 cu. yd. or fraction thereof.
  - 2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
    - a. When frequency of testing provides fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  - 3. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
  - 4. Air Content: ASTM C231/C231M, pressure method, for normal-weight concrete; ASTM C173/C173M, volumetric method, for structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  - 5. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F and below or 80 deg F and above, and one test for each composite sample.
  - 6. Unit Weight: ASTM C567/C567M, fresh unit weight of structural lightweight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  - 7. Compression Test Specimens: ASTM C31/C31M.
    - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample.
    - b. Cast and field cure two sets of two standard cylinder specimens for each composite sample.
  - 8. Compressive-Strength Tests: ASTM C39/C39M; test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days.
    - a. Test one set of two field-cured specimens at 7 days and one set of two specimens at 28 days.

- b. A compressive-strength test shall be the average compressive strength from a set of two specimens obtained from same composite sample and tested at age indicated.
  - 9. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
  - 10. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
  - 11. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
  - 12. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
  - 13. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M or by other methods as directed by Architect.
  - 14. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
  - 15. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- E. Measure floor and slab flatness and levelness according to ASTM E1155 within 24 hours of finishing.

### **3.17 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Steel
  - 3. Plastic Materials
  - 4. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 03 30 00**



## **SECTION 04 20 00 - UNIT MASONRY**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Concrete masonry units.
  - 2. Mortar and grout.
  - 3. Steel reinforcing bars.
  - 4. Masonry-joint reinforcement.
  - 5. Ties and anchors.
  - 6. Miscellaneous masonry accessories.
- B. Products Installed but not Furnished under This Section:
  - 1. Steel lintels in unit masonry.
  - 2. Steel shelf angles for supporting unit masonry.
- C. Related Requirements:
  - 1. Division 03 Section "Cast-in-Place Concrete" for installing dovetail slots for masonry anchors.
  - 2. Division 04 Section "Exterior Stone Cladding" for stone trim secured with stone anchors.
  - 3. Division 05 Section "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
  - 4. Division 07 Section "Thermal Insulation" for cavity wall insulation.
  - 5. Division 07 Section "Sheet Metal Flashing and Trim" for sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.
  - 6. Division 32 Section "Unit Paving" for exterior unit masonry paving.

#### **1.3 DEFINITIONS**

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

#### **1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For the following:
  - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
  - 2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.
  - 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples for Verification: For each type and color of the following:
  - 1. Accessories embedded in masonry.

## 1.6 INFORMATIONAL SUBMITTALS

- A. List of Materials Used in Constructing Mockups:
  - 1. Products in this section may be required in freestanding mockup.
  - 2. List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
  - 3. Submittal is for information only. Receipt of list does not constitute approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.
- B. Qualification Data: For testing agency.
- C. Material Certificates: For each type and size of the following:
  - 1. Masonry units.
    - a. Include data on material properties and material test reports substantiating compliance with requirements.
    - b. For masonry units, include data and calculations establishing average net-area compressive strength of units.
  - 2. Cementitious materials. Include name of manufacturer, brand name, and type.
  - 3. Mortar admixtures.
  - 4. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
  - 5. Grout mixes. Include description of type and proportions of ingredients.
  - 6. Reinforcing bars.
  - 7. Joint reinforcement.
  - 8. Anchors, ties, and metal accessories.
- D. Mix Designs: For each type of mortar and grout, Include description of type and proportions of ingredients.
  - 1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C109/C109M for compressive strength, ASTM C1506 for water retention, and ASTM C91/C91M for air content.
  - 2. Include test reports, according to ASTM C1019, for grout mixes required to comply with compressive strength requirement.
- E. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to TMS 602/ACI 530.1/ASCE 6.
- F. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

## 1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualified according to ASTM C1093 for testing indicated.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

## 1.9 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
  - 1. Extend cover a minimum of 24 inches down both sides of walls, and hold cover securely in place.
  - 2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe, and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
  - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
  - 2. Protect sills, ledges, and projections from mortar droppings.
  - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
  - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. 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 TMS 602/ACI 530.1/ASCE 6.
  - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

## **2.2 PERFORMANCE REQUIREMENTS**

- A. Provide structural unit masonry that develops indicated net-area compressive strengths at 28 days.
  - 1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to TMS 602/ACI 530.1/ASCE 6.

## **2.3 UNIT MASONRY, GENERAL**

- A. Masonry Standard: Comply with TMS 602/ACI 530.1/ASCE 6, except as modified by requirements in the Contract Documents.
- B. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed Work.

## **2.4 CONCRETE MASONRY UNITS**

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
  - 1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
  - 2. Provide square-edged units for outside corners unless otherwise indicated.
- B. CMUs: ASTM C90.
  - 1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi or 2150 psi, as specified on drawings.
  - 2. Density Classification: Normal weight.
  - 3. Size (Width): Manufactured to dimensions 3/8 inch less than nominal dimensions.

## **2.5 MASONRY LINTELS**

- A. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs matching adjacent CMUs in color, texture, and density classification, with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

## **2.6 MORTAR AND GROUT MATERIALS**

- A. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
  - 1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C114.
- B. Mortar Cement: ASTM C1329/C1329M.
- C. Aggregate for Mortar: ASTM C144.
  - 1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
  - 2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
- D. Aggregate for Grout: ASTM C404.

- E. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494/C494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
- F. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.
- G. Water: Potable.

## 2.7 REINFORCEMENT

- A. Uncoated-Steel Reinforcing Bars: ASTM A615/A615M or ASTM A996/A996M, Grade 60.
- B. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148-inch steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
- C. Masonry-Joint Reinforcement for Single-Wythe Masonry: Ladder **or** truss type with single pair of side rods.

## 2.8 TIES AND ANCHORS

- A. General: Ties and anchors shall extend at least 1-1/2 inches into veneer but with at least a 5/8-inch cover on outside face.
- B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
  1. Mill-Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A641/A641M, Class 1 coating.
  2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A82/A82M, with ASTM A153/A153M, Class B-2 coating.
  3. Stainless Steel Wire: ASTM A580/A580M, Type 304.
  4. Galvanized-Steel Sheet: ASTM A653/A653M, Commercial Steel, G60 zinc coating.
  5. Steel Sheet, Galvanized after Fabrication: ASTM A1008/A1008M, Commercial Steel, with ASTM A153/A153M, Class B coating.
  6. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.
  7. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
  8. Stainless Steel Bars: ASTM A276 or ASTM A666, Type 304.
- C. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
  1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch-diameter, hot-dip galvanized steel wire.
  2. Tie Section: Triangular-shaped wire tie made from 0.187-inch- diameter, hot-dip galvanized steel wire.
- D. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
  1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.060-inch-thick steel sheet, galvanized after fabrication.
    - a. 0.064-inch-thick, galvanized-steel sheet may be used at interior walls unless otherwise indicated.
  2. Tie Section: Triangular-shaped wire tie made from 0.187-inch- diameter, hot-dip galvanized steel wire.

- E. Partition Top Anchors: 0.105-inch-thick metal plate with a 3/8-inch-diameter metal rod 6 inches long welded to plate and with closed-end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot-dip galvanized after fabrication.

## **2.9 MISCELLANEOUS MASONRY ACCESSORIES**

- A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D2000, Designation M2AA-805 or PVC, complying with ASTM D2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated felt complying with ASTM D226/D226M, Type I (No. 15 asphalt felt).

## **2.10 MASONRY CLEANERS**

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.

## **2.11 MORTAR AND GROUT MIXES**

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
  - 1. Do not use calcium chloride in mortar or grout.
  - 2. Use masonry cement or mortar cement mortar unless otherwise indicated.
  - 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. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
  - 1. For masonry below grade or in contact with earth, use Type M.
  - 2. For reinforced masonry, use Type S.
  - 3. For exterior, above-grade, load-bearing and nonload-bearing walls and parapet walls; for interior load-bearing walls; for interior nonload-bearing partitions; and for other applications where another type is not indicated, use Type N.
  - 4. For interior nonload-bearing partitions, Type O may be used instead of Type N.
- D. Grout for Unit Masonry: Comply with ASTM C476.
  - 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with TMS 602/ACI 530.1/ASCE 6 for dimensions of grout spaces and pour height.
  - 2. Proportion grout in accordance with ASTM C476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2500 psi.
  - 3. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C143/C143M.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
  - 2. Verify that foundations are within tolerances specified.
  - 3. Verify that reinforcing dowels are properly placed.
  - 4. Verify that substrates are free of substances that impair mortar bond.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION, GENERAL**

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, 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.

### **3.3 TOLERANCES**

- A. Dimensions and Locations of Elements:
  - 1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
  - 2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
  - 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.
- B. Lines and Levels:
  - 1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2-inch 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, 1/4 inch in 20 feet, or 1/2-inch maximum.
  - 3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
  - 4. 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, 1/4 inch in 20 feet, or 1/2-inch maximum.
  - 5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2-inch maximum.
  - 6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet or 1/2-inch maximum.

7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
- C. Joints:
1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
  2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
  3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
  4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch.
  5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

### 3.4 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 horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond. Bond and interlock each course of each wythe at corners. Do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below, and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build nonload-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
  1. Install compressible filler in joint between top of partition and underside of structure above.
  2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch clearance between end of anchor rod and end of tube. Space anchors 48 inches o.c. unless otherwise indicated.
  3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Division 07 Section "Joint Firestopping."



### **3.5 MORTAR BEDDING AND JOINTING**

- A. Lay CMUs as follows:
  - 1. Bed face shells in mortar and make head joints of depth equal to bed joints.
  - 2. Bed webs in mortar in all courses of piers, columns, and pilasters.
  - 3. Bed webs in mortar in grouted masonry, including starting course on footings.
  - 4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
  - 5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.
- 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. Set trim units in full bed of mortar with full vertical joints. Fill dowel, anchor, and similar holes.
  - 1. Clean soiled surfaces with fiber brush and soap powder and rinse thoroughly with clear water.
  - 2. Allow cleaned surfaces to dry before setting.
  - 3. Wet joint surfaces thoroughly before applying mortar.
  - 4. Rake out mortar joints for pointing with sealant.
- D. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- E. Cut joints flush for masonry walls to receive plaster or other direct-applied finishes (other than paint) unless otherwise indicated.
- F. Cut joints flush where indicated to receive waterproofing, cavity wall insulation and/or air barriers unless otherwise indicated.

### **3.6 MASONRY-JOINT REINFORCEMENT**

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
  - 1. Space reinforcement not more than 16 inches o.c.
  - 2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
  - 3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
- 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.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

### **3.7 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE**

- A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to comply with the following:
  - 1. Provide an open space not less than 1 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
  - 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.

3. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

### **3.8 CONTROL AND EXPANSION JOINTS**

- A. General: Install control joint materials in unit masonry as masonry progresses. Do not allow materials to span control joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry using one of the following methods:
  1. Fit bond-breaker strips into hollow contour in ends of CMUs on one side of control joint. Fill resultant core with grout, and rake out joints in exposed faces for application of sealant.
  2. Install preformed control-joint gaskets designed to fit standard sash block.
  3. Install interlocking units designed for control joints. Install bond-breaker strips at joint. Keep head joints free and clear of mortar, or rake out joint for application of sealant.
  4. Install temporary foam-plastic filler in head joints, and remove filler when unit masonry is complete for application of sealant.
- C. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants," but not less than 3/8 inch.
  1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

### **3.9 LINTELS**

- A. Install steel lintels where indicated.
- B. Provide concrete or masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.
- C. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

### **3.10 FLASHING**

- A. General: Install embedded flashing in masonry where indicated.
- B. Install flashing as indicated on drawings.
- C. Install single-wythe CMU flashing system in bed joints of CMU walls where indicated to comply with manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.
- D. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

### **3.11 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 that of other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in TMS 602/ACI 530.1/ASCE 6.
  - 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 TMS 602/ACI 530.1/ASCE 6 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.

### **3.12 FIELD QUALITY CONTROL**

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Inspections: Special inspections according to Level A in TMS 402/ACI 530/ASCE 5.
  1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
  2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
  3. Place grout only after inspectors have verified proportions of site-prepared grout.
- C. Testing Prior to Construction: One set of tests.
- D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
- E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C140 for compressive strength.
- F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C780.
- G. Mortar Test (Property Specification): For each mix provided, according to ASTM C780. Test mortar for mortar air content and compressive strength.
- H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C1019.

### **3.13 REPAIRING, POINTING, AND CLEANING**

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.
  
6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
7. Clean stone trim to comply with stone supplier's written instructions.

### **3.14 MASONRY WASTE DISPOSAL**

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Masonry Waste Recycling: Return broken CMUs not used as fill to manufacturer for recycling.
- C. Excess Masonry Waste: Remove excess clean masonry waste, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

**END OF SECTION 04 20 00**

## **SECTION 04 42 00 - STONE CLADDING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  1. New slate stone panels mechanically anchored on steel stud frames & masonry.
  2. Existing/salvaged slate stone panels mechanically anchored on steel stud frames & masonry.
- B. Related Requirements:
  1. Division 01 Section "Quality Requirements" for Delegated Design.
  2. Division 04 Section "Unit Masonry" for infilling of door openings.
  3. Division 04 Section "Stone Masonry" for granite copings and sills to be installed with stone cladding.
  4. Division 05 Section "Structural Steel Framing" for steel supporting stone cladding.
  5. Division 05 Section "Cold-Formed Metal Framing" for steel stud frames supporting stone cladding.
  6. Division 07 Section "Fluid- Applied Membrane and Air and Vapor Barriers" for air and water management system behind the exterior stone cladding.
  7. Division 07 Section "Rainscreen Attachment System"
  8. Division 07 Section "Sheet Metal Flashing and Trim" for water management system behind the exterior stone cladding.
  9. Division 07 Section "Joint Sealants" for sealing joints in stone cladding system with elastomeric sealants.
  10. Division 09 Section "Painting" for coating of existing steel gravity supports to be reused. remain

#### **1.3 DEFINITIONS**

- A. Definitions contained in ASTM C119 apply to this Section.
- B. IBC: International Building Code.
- C. Stone Cladding Assembly: An exterior wall covering system consisting of stone panels together with anchors, CFMF backup, structural steel gravity support, secondary weather barrier, sheathing, fasteners, and sealants used to secure the stone to the building structure and to produce a weather-resistant covering.

#### **1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference on stone cladding at project site.
  1. Review extents and procedure for stone removal and stone installation.
  2. Review coordination of items scheduled for removal by the stone contractor and removal of stone cladding.
  3. Review schedule. Material procurement and availability.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each slate stone, stone accessory, and manufactured product.

- B. Shop Drawings: Show fabrication and installation details for stone cladding assembly, including dimensions and profiles of stone units.
  1. Show locations and details of joints both within stone cladding assembly and between stone cladding assembly and adjoining construction.
  2. Include details of sealant joints and/or mortar joints pointed with sealant.
  3. Show locations and details of anchors and backup structure.
  4. Show direction of veining, grain, or other directional pattern.
  5. Include large-scale shaded elevations and details of interfacing with adjoining assemblies.
- C. Samples for Initial Selection: For joint materials involving color selection.
- D. Stone Samples for Verification: Sets for each variety, color, and finish of stone required.
  1. Sets shall consist of at least four 4"x8"x1¼" samples of new stone, exhibiting extremes of the full range of color and other visual characteristics expected and will establish the standard by which stone will be judged.
  2. Provide at least four 4"x8" samples of cleaned existing salvaged stone for comparison, also showing full range of color and other visual characteristics.
- E. Sealant Samples for Verification: For each type and color of joint sealant required.
- F. Delegated-Design Submittal: For stone cladding assembly.
- G. Salvaged Stone Panel Inventory.
- H. Mortar samples for stone masonry at grade.

#### **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For installer.
- B. Material Test Reports:
  1. Stone Test Reports: For slate stone variety proposed for use on Project, by a qualified testing agency, indicating compliance with required physical properties, other than abrasion resistance, according to referenced ASTM standards. Base reports on testing done within previous three years.
  2. Sealant Compatibility and Adhesion Test Report: From sealant manufacturer complying with requirements in Division 07 Section "Joint Sealants" and indicating that sealants will not stain or damage stone. Include interpretation of test results and recommendations for primers and substrate preparation needed for adhesion.
  3. Mortar Test Reports: Preconstruction test report.
- C. Source quality-control reports.
- D. Quality-control program.
- E. Stone removal and installation program.

#### **1.7 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Stone Units: 2 for each size of stone specified.

## 1.8 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom fabricate stone cladding assemblies similar to that required for this Project and whose products have a record of successful in-service performance.
- B. Installer Qualifications: A firm or individual experienced in installing stone cladding assemblies similar in material, design, and extent to that indicated for this Project, whose work has a record of successful in-service performance.
- C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  - 1. Build freestanding mockups of typical exterior wall area as shown in Drawings on sheet A0.60.
    - a. Include typical components, attachments to building structure, and methods of installation.
    - b. Include window opening.
    - c. Include gravity support.
    - d. Include sealant-filled joint complying with requirements in Division 07 Section "Joint Sealants."
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.9 PRECONSTRUCTION TESTING

- A. Preconstruction Sealant Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for compatibility and adhesion testing according to sealant manufacturer's standard testing methods and Division 07 Section "Joint Sealants," Samples of materials that will contact or affect joint sealants.
- B. Preconstruction Field Testing of Sealants: Before installing joint sealants, field test their adhesion to joint substrates according to Division 07 Section "Joint Sealants."
- C. Existing Stone: Test each type of existing stone indicated for replacement for compliance with ASTM C629 Class I material properties, according to ASTM C170/C170M for compressive strength, wet and dry, perpendicular and parallel to rift; ASTM C99/C99M for modulus of rupture, wet and dry, perpendicular and parallel to rift; and ASTM C97/C97M for absorption and bulk specific gravity. Carefully remove three existing stones for testing from locations designated by Architect. Take testing samples from these stones.

## 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Store and handle stone and related materials to prevent deterioration or damage due to moisture, temperature changes, contaminants, corrosion, breaking, chipping, and other causes.
  - 1. Lift stone with wide-belt slings; do not use wire rope or ropes that might cause staining. Move stone, if required, using dollies with cushioned wood supports.
  - 2. Store stone on wood skids or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to stone. Ventilate under covers to prevent condensation.
- B. Mark stone units, on surface that will be concealed after installation, with designations used on Shop Drawings to identify individual stone units. Orient markings on vertical panels so that they are right side up when units are installed.

- C. Deliver sealants to Project site in original unopened containers labeled with manufacturer's name, product name and designation, color, expiration period, pot life, curing time, and mixing instructions for multicomponent materials.
- D. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- E. Store aggregates in locations where grading and other required characteristics can be maintained and where contamination can be avoided.

### **1.11 FIELD CONDITIONS**

- A. Protect stone cladding during erection by doing the following:
  1. Cover tops of stone cladding installation 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 inches (600 mm) down both sides and hold securely in place.
  2. Prevent staining of stone from mortar, grout, sealants, and other sources. Immediately remove such materials without damaging stone.
  3. Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on ground and over wall surface.
  4. Protect sills, ledges, and projections from mortar and sealant droppings.
- B. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Remove and replace stone cladding damaged by frost or freezing conditions. Comply with cold-weather construction and protection requirements for masonry contained in TMS 602/ACI 530.1/ASCE 6.
- C. Hot-Weather Requirements: Comply with hot-weather construction and protection requirements for masonry contained in TMS 602/ACI 530.1/ASCE 6.
- D. Environmental Limitations for Sealants: Do not install sealants when ambient and substrate temperatures are outside limits permitted by sealant manufacturer or when joint substrates are wet.

### **1.12 COORDINATION**

- A. Coordinate installation of inserts that are to be embedded in concrete or masonry, flashing reglets, attached to CFMF, rainscreen attachment system, structural steel supports and similar items to be used by stone cladding Installer for anchoring, supporting, and flashing of stone cladding assembly. Furnish setting drawings, templates, and directions for installing such items and deliver to Project site in time for installation.
- B. Time delivery and installation of stone cladding to avoid extended on-site storage and to coordinate with work adjacent to stone cladding.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Source Limitations for Stone: Obtain slate stone, from single quarry with resources to provide materials of consistent quality in appearance and physical properties.
  1. Basis of Design – Pennsylvania Black slate available from Penn Big Bed Slate Company, P.O. Box 184, 8459 Brown Street Slatington, PA 18080, or approved equivalent.
  2. Make quarried blocks available for examination by Architect.



- B. Source Limitations for Mortar Materials: Obtain mortar ingredients of uniform quality for each cementitious component from single manufacturer and each aggregate from single source or producer.
- C. Source Limitations for Other Materials: Obtain each type of stone accessory and other material from single manufacturer for each product.

## **2.2 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design stone cladding assembly.
- B. General: Design stone anchors and anchoring systems according to ASTM C1242.
- C. Structural Performance: Stone cladding assembly shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
  - 1. Wind Loads: As indicated on structural drawings.
  - 2. Equipment Loads: Allow for loads due to window cleaning and maintenance equipment.
- D. Seismic Performance: Stone cladding assembly shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. Component Importance Factor: 1.0 (exception 1.5 to be utilized for stone cladding design in egress stairways).
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- F. Horizontal Building Movement (Interstory Drift): Allow for maximum horizontal building movement equal to quotient resulting from dividing floor-to-floor height at any floor by 400.
- G. Safety Factors for Stone: Design stone cladding assembly to withstand loads indicated without exceeding stone's allowable working stress determined by dividing stone's average ultimate strength, as established by testing, by the following safety factors:
  - 1. Safety Factor for Slate: 5.
  - 2. Safety Factor for Concentrated Stresses: 10.
- H. Design stone anchors and backup structure to withstand loads indicated without exceeding allowable working stresses established by the following:
  - 1. For Structural Steel: AISC 360.
  - 2. For Cold-Formed Steel: AISI's "North American Specification and Commentary for the Design of Cold-Formed Steel Structural Members."
  - 3. For Cast-in-Place and Postinstalled Fasteners in Concrete: One-fourth of tested capacity when installed in concrete with compressive strength indicated.
  - 4. For Postinstalled Fasteners in Masonry: One-sixth of tested capacity when installed in masonry units indicated.
  - 5. For rainscreen attachment system as established during the rainscreen attachment delegated design submission.
- I. Limit deflection in each prefabricated assembly caused by indicated loads and thermal movements, acting singly or in combination with one another, to not more than 1/720 of assembly's clear span or the following, whichever is smaller:
  - 1. 1/16 inch (1.5 mm), measured in plane of wall.
  - 2. 1/4 inch (6 mm), measured perpendicular to wall.

- J. Provisions for Fabrication and Erection Tolerances: Allow for fabrication and erection tolerances of building's structural system. Structural-steel fabrication and erection tolerances are specified in Division 05 Sections "Structural Steel Framing." and "Metal Fabrications."
- K. Provision for Deflection of Building Structure:
  - 1. Deflection Due to Weight of Stone Cladding Assembly: Allow for 1/4-inch (6-mm) vertical deflection in 20-foot (6-m) span of structural members supporting stone cladding assembly.
- L. Corrosion and Staining Control: Prevent galvanic and other forms of corrosion as well as staining by isolating metals and other materials from direct contact with incompatible materials. Materials shall not stain exposed surfaces of stone and joint materials.

### **2.3 SLATE**

- A. Material Standard: Comply with ASTM C629/C629M, Classification I Exterior
- B. Description: Blue Gray to Gray Black S1 quality slate with a fine, even grain and unfading color, from clear, sound stock.
- C. Varieties and Sources: Subject to compliance with requirements, provide the following:
  - 1. Pennsylvania Black as available from Penn Big Bed Slate Company, P.O. Box 184, 8459 Brown Street Slatington, PA 18080, or approved equivalent.
  - 2. Make quarried blocks available for examination by Architect.
- D. Finish: Natural cleft to match the existing stone façade materials.
- E. Thickness: Not less than 1-1/4 inches (32 mm) and 2 1/2" inches (76 mm) at base unless indicated otherwise.

### **2.4 ANCHORS AND FASTENERS**

- A. Fabricate anchors from stainless steel, ASTM A240/A240M or ASTM A666, Type 304; temper as required to support loads imposed without exceeding allowable design stresses. Fabricate dowels and pins for anchors from stainless steel, ASTM A276, Type 304.
  - 1. Provide anchors spaced not more than 24 inches apart around the periphery of each unit with not less than four anchors per veneer panel.
- B. Fabricate shelf angles for slate from hot-dip galvanized steel, ASTM A36/A36M for materials and ASTM A123/A123M for galvanizing.
- C. Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon nuts, and hardened washers.
  - 1. For stainless steel, use annealed stainless-steel bolts, nuts, and washers; for bolts, ASTM F593 (ASTM F738M); and for nuts, ASTM F594 (ASTM F836M).

### **2.5 MORTAR MATERIALS**

- A. Portland Cement: ASTM C150/C150M, Type I or Type II, except Type III may be used for cold-weather construction, natural color or white as required to produce mortar color indicated.
  - 1. Low-Alkali Cement: Portland cement for use with limestone shall contain no more than 0.60 percent total alkali when tested according to ASTM C114.
- B. Hydrated Lime: ASTM C207.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime.

- D. Colored Portland Cement-Lime Mix: Packaged blend of portland cement, hydrated lime, and mortar pigments. Mix shall produce color indicated or, if not indicated, as selected from manufacturer's standard colors. Pigments shall not exceed 10 percent of portland cement by weight.
- E. Aggregate: ASTM C144; except for joints narrower than 1/4 inch (6 mm)] pointing mortar, 100 percent shall pass No. 16 (1.18-mm) sieve.
  - 1. White Aggregates: Natural white sand or ground white stone.
  - 2. Colored Aggregates: Natural-colored sand or ground marble, granite, or other durable stone; of color necessary to produce required mortar color.
- F. Water: Potable.

## 2.6 STONE ACCESSORIES

- A. Setting Shims: Strips of resilient plastic, non-staining to stone, of thickness needed to prevent point loading of stone on anchors and of depths to suit anchors without intruding into required depths of pointing materials.
- B. Setting Buttons: Resilient plastic buttons, non-staining to stone, sized to suit joint thicknesses and bed depths of stone units without intruding into required depths of pointing materials.
- C. Concealed Sheet Metal Flashing: Fabricated from stainless steel in thicknesses indicated, but not less than 0.0156 inch (0.4 mm) thick and complying with Division 07 Section "Sheet Metal Flashing and Trim."
- D. Weep and Vent Tubes: Rectangular, cellular, polypropylene or clear butyrate extrusion, 3/8 by 1-1/2 inches (9 by 38 mm), of length required to extend from exterior face of stone to cavity behind.
- E. Sealants for Joints in Stone Cladding: Manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that comply with applicable requirements in Division 07 Section "Joint Sealants" and do not stain stone:
  - 1. Joint Sealant: Silicone, non-staining, S, NS, 50, NT.
  - 2. Joint-Sealant Colors: As selected by Architect from manufacturer's full range of colors.
- F. Sealant for Filling Kerfs: Same sealant used for joints in stone cladding.
- G. Silicone, Non-staining, S, NS, 50, NT: Non-staining, single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C920, Type S, Grade NS, Class 50, Use NT.
  - a. Pecora: 890 NST - FTS - Field Tinted
  - b. Tremco: Spectrum 1
  - c. Or approved equivalent.
- H. Slate Repair Mortar: Provide single component, cementitious, mineral based, premixed patching mortar.
  - 1. Products: Subject to compliance with requirements, provide the following:
    - a. Jahn M160 Repair Mortar as manufactured by Cathedral Stone Products, Inc., or approved equivalent.

## 2.7 STONE FABRICATION

- A. General: Fabricate stone units in sizes and shapes required to comply with requirements indicated.

- B. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated. Shape beds to fit supports.
- C. Cut and drill sinkages and holes in stone for anchors, fasteners, supports, and lifting devices as indicated or needed to set stone securely in place.
- D. Finish exposed faces and edges of stone, to comply with requirements indicated for finish and to match approved samples and mockups.
- E. Cut stone to produce uniform joints 5/16 inch wide and in locations indicated.
- F. Contiguous Work: Provide chases, reveals, reglets, openings, and similar features as required to accommodate contiguous work.
- G. Clean backs of stone to remove rust stains, iron particles, and stone dust.
- H. Inspect finished stone units at fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units.
  - 1. Grade and mark stone for overall uniform appearance when assembled in place. Natural variations in appearance are acceptable if installed stone units match range of colors and other appearance characteristics represented in approved samples and mockups.

## **2.8 FABRICATION OF BACKUP STRUCTURE**

- A. Fabrication of Steel Framing: Fabricate in shop to comply with AISC 303.
  - 1. Weld shop connections to comply with applicable provisions of AWS D1.1/D1.1M.
  - 2. Fabricate joints to exclude water or to permit its escape to building exterior, at locations where water could accumulate because of condensation or other causes.
  - 3. Hot-dip galvanize backup structure after fabrication to comply with ASTM A123/A123M.
- B. Fabrication of Steel Stud Frames: Fabricate and assemble by welding to comply with requirements in Section 05 40 00 "Cold-Formed Metal Framing."
- C. Fabrication of rainscreen attachment system to receive stone anchors to comply with Division 07 Section "Rainscreen Attachment System".

## **2.9 SHOP-PAINTED STEEL FINISHES**

- A. General: Paint uncoated steel backup structure before delivering to Project site to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel."
- B. Surface Preparation: After fabricating steel items, prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- C. Apply two-coat, high-performance coating system consisting of epoxy zinc-rich primer, complying with MPI#20 and topcoat of high-build epoxy coating, complying with MPI#108.

## **2.10 MORTAR MIXES**

- A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortar of uniform quality and with optimum performance characteristics.
  - 1. Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated. Do not use calcium chloride.

2. Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer unless otherwise indicated. Discard mortar when it has reached initial set.
- B. Portland Cement-Lime Setting Mortar: Comply with ASTM C270, Proportion Specification, Type S.
  - C. Pointing Mortar: Comply with ASTM C270, Proportion Specification, Type N. Provide pointing mortar mixed to match Architect's sample and complying with the following:
    1. Packaged Portland Cement-Lime Mix Mortar: Use portland cement-lime mix of selected color.

## **2.11 SOURCE QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to perform source quality-control testing.
  1. Furnish test specimens randomly selected from same blocks as actual materials proposed for incorporation into the Work.
  2. Flexural Strength Tests: ASTM C880/C880M, performed on specimens of same thickness, orientation of cut, and finish as installed stone. One set of test specimens is required to be tested for every 5000 sq. ft. (500 sq. m), but not fewer than two sets for each stone variety.

## **PART 3 - EXECUTION**

### **3.1 SLATE PANEL REMOVAL**

- A. Carefully remove the existing slate panels from the building and transport to an on-site staging area:
  1. Organize laydown area by stone band type and size.
  2. Conduct review of each stone panel to cull stone panels unfit for reuse, based on the following criteria/methodologies:
    - a. Inspect all cut edges of the panels for cracking and spalls. Panels with visible cracks and/or spalls shall constitute a panel unfit for reuse.
    - b. Sound surface of all panels for delamination. Delamination shall constitute a panel unfit for reuse.
  3. Develop unique code to record and track individual stones.
  4. Provide and maintain a salvaged stone panel inventory schedule organized by panel type, size, setting block and count. This document is to be used by the stone panel engineer and stone supplier to generate shop drawings and facilitate the design of the new stone panel layout and design by the stone engineer.

### **3.2 EXAMINATION**

- A. Examine surfaces to receive stone cladding and conditions under which stone cladding will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of stone cladding.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of stone cladding.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.3 INSTALLING BACKUP STRUCTURE**

- A. Installing stone gravity support Steel Framing: Comply with AISC 303 and install to accommodate construction tolerances specified.

1. Maintain erection of backup structure within tolerances in AISC 303.
  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. Installing Steel Stud Frames: Comply with requirements in Division 05 Section "Cold-Formed Metal Framing."
1. Install steel stud frames level, plumb, and true to line with no variation in plane or alignment exceeding 1/16 inch (1.5 mm) and no variation in position exceeding 1/8 inch (3 mm).
  2. Clean welds, bolted connections, and abraded areas immediately after erection. Repair galvanizing to comply with ASTM A780/A780M.
- C. Installing Rainscreen Attachment System: Comply with the requirements of Division 07 Section "Rainscreen Attachment System"
1. Coordinate stone anchorage requirements with rainscreen attachment system installation and shop drawings.

### **3.4 SETTING STONE CLADDING, GENERAL**

- A. Before setting stone, clean surfaces that are dirty or stained by removing soil, stains, and foreign materials. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.
1. Keep expansion joints free of mortar and other rigid materials.
- B. Install concealed flashing at continuous shelf angles, lintels, ledges, and similar obstructions to downward flow of water, to divert water to building exterior. Extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.
- C. 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 at base of cavity walls and above shelf angles and flashing. Locate weep holes at each vertical joint.

### **3.5 SETTING MECHANICALLY ANCHORED STONE CLADDING**

- A. Set stone cladding with mechanical anchors without mortar unless otherwise indicated.
- B. Attach anchors securely to stone and to backup surfaces. Comply with recommendations in ASTM C1242.
- C. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with sealant indicated for filling kerfs.
- D. Set stone supported on clips or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths and to prevent point loading of stone on anchors. Hold shims back from face of stone a distance at least equal to width of joint.

### **3.6 SETTING STONE CLADDING WITH MORTAR**

- A. Set stone cladding with mortar and mechanical anchors where indicated at the foundation panels.
1. Use setting buttons of adequate size, in sufficient quantity, and of thickness required to maintain uniform joint width and to prevent mortar from extruding. Hold buttons back from face of stone a distance at least equal to width of joint, but not less than depth of pointing materials.

2. Do not set heavy units or projecting courses until mortar in courses below has hardened enough to resist being squeezed out of joint.
  3. Support and brace projecting stones until wall above is in place and mortar has set.
  4. Provide compressible filler in ends of dowel holes and bottoms of kerfs to prevent end bearing of dowels and anchor tabs on stone. Fill remainder of anchor holes and kerfs with mortar.
- B. Fill space between back of stone units and backup wall where below grade solidly with mortar or grout.
  - C. Embed ends of sills in mortar; leave remainder of joint open until final pointing.
  - D. Rake out mortar from sealant-pointed joints to depths required for sealant and sealant backing, but not less than 1/2 inch (12 mm). Rake joints to uniform depths with square bottoms and clean sides.

### **3.7 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."

### **3.8 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), 3/8 inch in 20 feet (10 mm in 6 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), 1/4 inch in 20 feet (6 mm in 6 m), or 3/8 inch in 40 feet (10 mm in 12 m) or more.
- B. Variation from Level: For lintels, sills, water tables, parapets, horizontal bands, horizontal grooves, and other conspicuous lines, do not exceed 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 3/8 inch (10 mm) maximum.
- C. Variation of Linear Building Line: For positions shown in plan and related portions of walls and partitions, 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 Cross-Sectional Dimensions: For thickness of walls from dimensions indicated, do not exceed plus or minus 1/4 inch (6 mm).
- E. 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. For joints within 60 inches (1500 mm) of each other, do not vary more than 1/8 inch (3 mm) or a quarter of nominal joint width, whichever is less from one to the other.
- F. Variation in Plane between Adjacent Stone Units (Lipping): Do not exceed 1/16-inch (1.5-mm) difference between planes of adjacent units.

### **3.9 ADJUSTING AND CLEANING**

- A. Remove and replace broken, chipped, stained, or otherwise damaged stone, defective joints, and stone cladding that does not match approved samples and mockups. Damaged stone may be repaired if Architect approves methods and results.
- B. Replace damaged or defective work in a manner that results in stone cladding's matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.

- C. In-Progress Cleaning: Clean stone cladding as work progresses. Remove excess sealant and smears as sealant is installed.
- D. Final Cleaning: Clean stone cladding no fewer than six days after completion of pointing and sealing, using clean water and stiff-bristle fiber brushes. Do not use wire brushes, acid-type cleaning agents, cleaning agents containing caustic compounds or abrasives, or other materials or methods that could damage stone.

**END OF SECTION 04 42 00**



## **SECTION 04 43 00 – STONE MASONRY**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes the following applications of stone masonry:
  1. Exterior Core A Entry Pavers
  2. Full Stone Veneer for Exterior and Interior Walls, Seat Wall and Curb
  3. Stone Veneer at Circulation Desk
  4. Exterior Stone Coping
  5. Exterior Stone Terrace Edge Pavers
  6. Interior Stone Stair Treads, Landings and Thresholds
- B. Related Sections:
  1. Division 04 Section "Unit Masonry" for horizontal joint reinforcement.
  2. Division 04 Section "Stone Cladding" for anchors used with granite coping and sills.
  3. Division 05 Section "Cold Formed Metal Framing" for backup wall for full height stone walls associated with building envelope.
  4. Division 05 Section "Decorative Metal" for stainless steel bars set into stone stair treads.
  5. Division 07 Section "Thermal Insulation" for cavity wall insulation behind stone veneer.
  6. Division 07 Section "Sheet Metal Flashing and Trim" for concealed and exposed sheet metal flashing.
  7. Division 07 Section "Joint Sealants" for sealing joints with elastomeric sealants.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
  1. For stone varieties proposed for use on Project, include test data indicating compliance with physical properties required by referenced ASTM standards.
- B. Shop Drawings: Include plans, sections, details, and attachments to other work.
  1. Show locations and details of joints both within stone floors, benches, etc., and between stone flooring and other finish materials.
- C. Samples for Initial Selection: For colored mortar and other items involving color selection.
- D. Samples for Verification:
  1. For each stone type indicated. Include at least five samples in each set for each type of stone, exhibiting extremes of the full range of color and other visual characteristics expected in completed Work. Samples will establish the standard by which stone provided will be judged.
  2. For each color of mortar required. Label Samples to indicate types and amounts of pigments used.
- E. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, sources of supply, and other information as required to identify materials used. Include mix proportions for mortar and source of aggregates.

1. Submittal is for information only. Neither receipt of list nor approval of mockups constitutes approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Landscape Architect and approved in writing.

F. Qualification Data: For qualified Installer.

#### **1.4 QUALITY ASSURANCE**

- A. Installer Qualifications: A qualified installer who employs experienced stonemasons and stone fitters.
- B. Source Limitations for Stone: Obtain stone, regardless of finish, from one quarry, whether specified in this Section or in another Section of the Specifications, with resources to provide materials of consistent quality in appearance and physical properties. Stone must be quarried within 500 miles of project site. Provide architect and landscape architect with quarry address and contact information.
- C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.
- D. Mockups: Build mockups to demonstrate aesthetic effects and set quality standards for materials and execution.
  1. Build freestanding mockup of typical wall area as shown on Drawings including stone wall, CMU retaining wall with stone veneer on both sides.
  2. Build in place mockups for each type of stone masonry in sizes approximately 60 inches (1500 mm) long by 48 inches high by full thickness, including face and backup wythes and accessories.
    - a. Include stone coping at top of mockup.
    - b. Include a sealant-filled joint at least 16 inches long in mockup.
    - c. Include veneer anchors and scupper in exterior wall mockup.
    - d. Include vertical control joint in exterior wall mockup.
  3. Approval of mockups is for color, texture, and blending of stone; relationship of mortar and sealant colors to stone colors; tooling of joints; and aesthetic qualities of workmanship.
    - a. Approval of mockups is also for other material and construction qualities Architect specifically approves in writing.
    - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- E. Preinstallation Conference: Conduct conference at Project site.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- B. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- C. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

- D. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

## **1.6 PROJECT CONDITIONS**

- A. Protection of Stone Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed stone masonry when construction is not in progress.
  - 1. Extend cover a minimum of 24 inches (600 mm) down both sides and hold cover securely in place.
- B. Stain Prevention: Immediately remove mortar and soil to prevent them from staining the face of stone masonry.
  - 1. Protect base of walls from rain-splashed mud and mortar splatter by coverings spread on the ground and over the wall surface.
  - 2. Protect sills, ledges, and projections from mortar droppings.
  - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
- C. 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 stone masonry damaged by frost or freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
  - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

## **1.7 COORDINATION**

- A. Advise installers of other work about specific requirements for placement of reinforcement, veneer anchors, flashing, and similar items to be built into stone masonry.

## **PART 2 - PRODUCTS**

### **2.1 BLUESTONE, GENERAL**

- A. Provide bluestone that meets the following performance criteria:
  - 1. Minimum Compressive Strength per ASTM C 170: 4000 psi (28 MPa).
  - 2. Minimum Flexural Strength per ASTM C 880
  - 3. Minimum Modulus of Rupture per ASTM C 99

### **2.2 GRANITE, GENERAL**

- A. Material Standard: Comply with ASTM C615/C615M.

### **2.3 GRANITE COPING & WINDOW SILLS (INTERIOR & EXTERIOR)**

- A. Description: Uniform, fine to medium-grained, black stone without veining.
- B. Varieties and Sources: Subject to compliance with requirements, provide one of the following stones or approved equivalent.
  - 1. Wisp Granite, from Quarra Stone Company.
  - 2. Pennsylvania Black, from Stone Contact, or other source of stone to match Architect's sample.

- C. Thickness: See Drawings.
- D. Finish: Sandblasted, or similar finish to match color of Architect's sample.

#### **2.4 EXISTING STONE CORE A ENTRY PAVERS**

- A. Provide sound natural stone as follows:
  - 1. Products: 2" thick rectangular paving to infill / replace broken stones at Core A patio.
  - 2. Color: Varigated, with range of colors to match existing paving.
  - 3. Finish on Horizontal Surfaces: Natural Cleft, to match existing paving.
  - 4. Pattern: To match existing.
- B. ALTERNATE: Replace all existing slate pavers at Core A patios on East and West sides of building.

#### **2.5 STONE VENEER FOR EXTERIOR RETAINING / SEATING WALL, INTERIOR WALLS AND CIRCULATION DESK**

- A. Provide sound natural stone as follows:
  - 1. Products: Full veneer (approximately 4" thick) Bluestone, uniformly 3" in height and 24" to 48" in length, unless noted otherwise on Drawings.
  - 2. Random ashlar coursing.
  - 3. Minimum 6" offset between head joints in consecutive courses.
  - 4. Color: Select Blue.
  - 5. Finish on Exposed Horizontal Surfaces: Thermal.
  - 6. Finish on Exposed Vertical Surfaces: Honed.
  - 7. Head joints in consecutive courses to be offset 6" minimum.

#### **2.6 EXTERIOR BLUESTONE COPING**

- A. Provide sound natural stone as follows:
  - 1. Products: Uniformly 3" in height.
  - 2. Color: Select Blue.
  - 3. Finish on Exposed Horizontal Surfaces: Thermal.
  - 4. Finish on Exposed Vertical Surfaces: Honed.
  - 5. See Drawings for stone coping sizes.

#### **2.7 EXTERIOR STONE TERRACE EDGE PAVERS**

- A. Provide sound natural stone as follows:
  - 1. Products: Uniformly 3" in height.
  - 2. Color: Select Blue.
  - 3. Finish on Exposed Horizontal Surfaces: Thermal.
  - 4. Finish on Exposed Vertical Surfaces: Honed.
  - 5. See Drawings for exterior stone threshold sizes.

#### **2.8 INTERIOR STONE STAIR TREADS, LANDINGS AND THRESHOLD**

- A. Provide sound natural stone as follows:
  - 1. Color: Select Blue.
  - 2. Finish: Thermal finish on all surfaces exposed to view.
  - 3. Stair Treads: 1-1/2 inch thick Bluestone
    - a. Each tread is to be a single stone
    - b. Treads are to be rectified within 1/32"
    - c. Treads are to be gauged to a uniform thickness
    - d. Nosing to be slightly eased

- e. Two (2) ¼" SS bar tactile warning strips are recessed into the walking surface at the tread nosing. See Drawings for size and placement.
- 4. Stair Landings: 3/4 inch thick Bluestone
  - a. Pattern as shown in the Drawings.
  - b. 1/8 inch joints.

## 2.9 MORTAR MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
  - 1. Low-Alkali Cement: Not more than 0.60 percent total alkali when tested according to ASTM C 114.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or III, and hydrated lime complying with ASTM C 207.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
    - b. Lafarge North America; Eaglebond.
    - c. Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
    - d. Or approved equivalent.
- D. Interior Stair Adhesive:
  - 1. Provide Latapoxy 210 Adhesive by Laticrete, or approved equivalent.
    - a. Modified emulsion epoxy adhesive, consisting of an emulsified epoxy resin and hardener, and pre-blended Portland cement and silica sand powder.
- E. Colored Cement Product: Packaged blend made from portland cement and lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.
  - 1. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
  - 2. Pigments shall not exceed 10 percent of portland cement by weight.
  - 3. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
  - 4. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Colored Portland Cement-Lime Mix:
      - 1) Holcim (US) Inc.; Rainbow Mortamix Custom Color Cement/Lime.
      - 2) Lafarge North America; Eaglebond.
      - 3) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
      - 4) Or approved equivalent.
- F. Aggregate: ASTM C 144 and as follows:
  - 1. For pointing mortar, use aggregate graded with 100 percent passing No. 16 sieve.
  - 2. Colored Aggregates: Natural-colored sand or ground marble, granite, or other sound stone; of color necessary to produce required mortar color.
- G. Water: Potable.

## 2.10 VENEER ANCHORS

- A. Materials:
  - 1. Stainless Steel Wire: ASTM A580/A580M, Type 304.
  - 2. Stainless Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304.

- B. Size: Sufficient to extend at least halfway, but not less than 1-1/2 inches, through stone masonry and with at least 5/8-inch cover on outside face.
- C. Adjustable, Screw-Attached Veneer Anchors: Units consisting of a wire tie section and a metal anchor section 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:
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Dur-O-Wal, a Dayton Superior Company
    - b. Heckmann Building Products Inc.;
    - c. Hohmann & Barnard, Inc.;
    - d. Wire-Bond;
    - e. Or approved equivalent.
  - 2. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.
- D. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C954 except manufactured with hex washer head and neoprene washer, No. 10 by length required to penetrate steel-stud flange with not less than three exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B117.
- E. Polymer-Coated, Steel Tapping Screws for Concrete Masonry: Self-tapping screws with specially designed threads for tapping and wedging into masonry, with hex washer head and neoprene washer, 3/16-inch diameter by 1-1/2-inch length, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ITW-Buildex; Tapcon.
    - b. Powers Fasteners; Tapper.
    - c. Or approved equivalent.

## **2.11 ANCHORS FOR GRANITE COPING AND SILLS**

- A. Stainless steel anchors for granite coping and sills to be designed and provided by provider of slate veneer anchoring system, as described in Division 04 Section "Stone Cladding."
  - 1. See 2.2 Performance Requirements and 2.4 Anchors and Fasteners in "Stone Cladding" section for delegated design and stainless steel requirements.

## **2.12 MISCELLANEOUS MASONRY ACCESSORIES**

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene urethane or PVC.
- B. Asphalt Dampproofing: Cut-back asphalt complying with ASTM D 4479, Type I or asphalt emulsion complying with ASTM D 1227, Type III or IV.
- C. Drainage Scupper: 1"x3" aluminum rectangular tube. Inlet and outlet side to be recessed into the face of the veneer a minimum of 3/4".
- D. Weep and Vent Tubes: Rectangular, cellular, polypropylene or clear butyrate extrusion, 3/8 by 1-1/2 inches (9 by 38 mm), of length required to extend from exterior face of stone to cavity behind.
- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Manufacturer and Type: CavClear Masonry Mat as manufactured by Archovations, Inc., or approved equivalent.
  2. Description: Full-height Air Space Maintenance and Cavity Drainage Mat. The masonry drainage mat shall be specifically designed for masonry cavities to prevent mortar from making contact with the backup and ensure water management. The masonry drainage mat shall be fluid conducting, non-absorbent, mold and mildew resistant polymer mesh consisting of 100% recycled plastic with binder fibers. Masonry drainage mat is to be a non-woven textile product in random pattern and have voids no greater than 1/4" in diameter. Masonry mat is to be designed for substantially continuous installation behind the full-height of all masonry.
  3. Masonry Drainage Mat Thickness: 1-3/4 inches to allow no more than 3/8 inch tolerance between the masonry mat and masonry wythe.
- F. Concealed Sheet Metal Flashing: Fabricated from stainless steel in thicknesses indicated, but not less than 0.0156 inch (0.4 mm) thick, and complying with **Division 07 Section** "Sheet Metal Flashing and Trim."
- G. Stainless Steel Dowels: For fixing granite coping in place. Delegated design installer to determine spacing.

### **2.13 MASONRY CLEANERS**

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar and grout stains, efflorescence, and other new construction stains from stone masonry surfaces without discoloring or damaging masonry surfaces; expressly approved for intended use by cleaner manufacturer and stone producer.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Diedrich Technologies, Inc.
    - b. Dominion Restoration Products.
    - c. EaCo Chem, Inc.
    - d. Hydrochemical Techniques, Inc.
    - e. Prosoco, Inc.
    - f. Or approved equivalent.

### **2.14 MORTAR AND GROUT MIXES**

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
1. Do not use calcium chloride.
  2. Limit cementitious materials in mortar 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.
  4. Mixing Pointing Mortar: Thoroughly mix cementitious and aggregate materials together before adding water. Then mix again, adding only enough water to produce a damp, unworkable mix that will retain its form when pressed into a ball. Maintain mortar in this dampened condition for one to two hours. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within 30 minutes of final mixing; do not retemper or use partially hardened material.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in the form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Stone Masonry: Comply with ASTM C 270, Property Specification.

1. Mortar for Setting Stone: Type S.
  2. Mortar for Pointing Stone: Type N.
- D. Latex-Modified Portland Cement Setting Mortar: Proportion and mix portland cement, aggregate, and latex additive to comply with latex-additive manufacturer's written instructions.
- E. Cement-Paste Bond Coat: Mix either neat cement and water or cement, sand, and water to a consistency similar to that of thick cream.
1. For latex-modified portland cement setting-bed mortar, substitute latex admixture for part or all of water, according to latex-additive manufacturer's written instructions.
- F. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
1. Pigments shall not exceed 10 percent of portland cement by weight.
- G. Pointing Mortar: Comply with requirements indicated above for setting mortar, including type and the following:
1. Pigmented Pointing Mortar: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1:10, by weight.
- H. Joint Grout: Comply with mixing requirements in referenced ANSI standards and with manufacturer's written instructions.

## **2.15 FABRICATION**

- A. Fabricate stone to comply with sizes, shapes, and tolerances recommended by applicable stone association or, if none, by stone source, for faces, edges, beds, and backs.
1. For stone not otherwise indicated, comply with recommendations in MIAs "Dimension Stone – Design Manual VII."
- B. Select stone to produce pieces of thickness, size, and shape indicated, including details on Drawings. Dress joints (bed and vertical) straight and at right angle to face unless otherwise indicated.
- C. Cut and drill sinkages and holes in stone for anchors and supports.
- D. Carefully inspect stone at quarry or fabrication plant for compliance with requirements for appearance, material, and fabrication. Replace defective units before shipment.
1. Clean sawed edges of stone to remove rust stains and iron particles.
  2. tool sawed edges of stone that are exposed to view, and create split face or natural cleft appearance. Exposed saw cuts and sawed edges shall be deemed unacceptable.
- E. Thickness of Stone: Provide thickness indicated, but not less than the following:
1. Thickness: 4 inches plus or minus 1/2 inch. Thickness does not include projection of pitched faces.
- F. Shape stone for type of wall masonry (pattern) as follows:
1. Running bond, random staggered joints
- G. Fabricate stone thresholds in sizes and profiles as indicated or required to provide transition between adjacent floor finishes.
1. Bevel edges of thresholds at 1:2 slope, aligning lower edge of bevel with adjacent floor finish. Limit height of bevel to 1/2" or less, and finish bevel to match adjacent surfaces of threshold.
- H. Stair treads and other stone where bottom is semi-exposed to view: Finish underside of stone stair treads and other stone material where underside is subjected to view.



## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine surfaces indicated to receive stone masonry, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine substrate to verify that dovetail slots, inserts, reinforcement, veneer anchors, flashing, and other items installed in substrates and required for or extending into stone masonry are correctly installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Coat concrete and unit masonry backup with asphalt dampproofing.
- B. Clean dirty or stained stone surfaces by removing soil, stains, and foreign materials before setting. Clean stone by thoroughly scrubbing with fiber brushes and then drenching with clear water. Use only mild cleaning compounds that contain no caustic or harsh materials or abrasives.

### **3.3 SETTING OF STONE MASONRY, GENERAL**

- A. Perform necessary field cutting and trimming as stone is set.
  - 1. Use hammer and chisel to split stone that is fabricated with split surfaces. Make edges straight and true, matching similar surfaces that were shop or quarry fabricated.
  - 2. Pitch face at field-split edges as needed to match stones that are not field split.
- B. Sort stone before it is placed in wall to remove stone that does not comply with requirements relating to aesthetic effects, physical properties, or fabrication, or that is otherwise unsuitable for intended use.
- C. Arrange stones in coursed rubble pattern with joint widths within tolerances indicated. Insert small stones into spaces between larger stones as needed to produce joints as uniform in width as practical.
- D. Arrange stones with color and size variations uniformly dispersed for an evenly blended appearance.
- E. Coat back (cavity) side of stone with dampproofing material. Before backfilling, coat exterior face of stone to within 2" of finished grade.
- F. Set stone to comply with requirements indicated on Drawings. Install supports, fasteners, and other attachments indicated or necessary to secure stone masonry in place. Set stone accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.
- G. Maintain uniform 1/2" joint widths except for variations due to different stone sizes and where minor variations are required to maintain bond alignment if any. Lay walls with joints not less than 3/8 inch at narrowest points or more than 5/8 inch at widest points.
- H. Provide sealant joints of widths and at locations indicated.
  - 1. Keep sealant joints free of mortar and other rigid materials.
  - 2. Sealing joints is specified in Division 07 Section "Joint Sealants."

### **3.4 CONSTRUCTION TOLERANCES FOR EXTERIOR STONE**

- A. Variation from Plumb: For vertical lines and surfaces, do not exceed 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch in 40 feet or more. For external corners, expansion joints, control joints, and other conspicuous lines, do not exceed 1/4 inch in 20 feet or 1/2 inch in 40 feet or more.
- B. Variation of Linear Building Line: For position shown in plan, do not exceed 1/2 inch in 20 feet or 3/4 inch in 40 feet or more.
- C. Measure variation from level, plumb, and position shown in plan as variation of the average plane of the face of each stone from level, plumb, or dimensioned plane.
- D. Variation in Mortar-Joint Thickness: Do not vary from joint size range indicated.
- E. Variation in Plane between Adjacent Stones: Do not exceed one-half of tolerance specified for thickness of stone.

### **3.5 CONSTRUCTION TOLERANCES FOR INTERIOR STONE**

- A. Variation in Line: For positions shown in plan for edges of flooring, ramps, steps, changes in color or finish, and continuous joint lines, do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 3/8 inch maximum.
- B. Variation in Joint Width: Do not vary from average joint width more than plus or minus 1/16 inch or one-fourth of nominal joint width, whichever is less.
- C. Variation in Surface Plane: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 3/8 inch maximum from level or slope indicated.
- D. Variation in Plane between Adjacent Units (Lipping): Do not exceed 1/32-inch difference between planes of adjacent units.

### **3.6 INSTALLATION OF ANCHORED STONE MASONRY**

- A. Anchor stone masonry to unit masonry with wire anchors unless otherwise indicated. Connect anchors to masonry joint reinforcement with vertical rods inserted through anchors and through eyes of masonry joint reinforcement projecting from unit masonry.
- B. Anchor stone masonry to stud framing with adjustable, screw-attached veneer anchors unless otherwise indicated. Fasten anchors through sheathing to framing with two screws.
- C. Embed veneer anchors in mortar joints of stone masonry at least halfway, but not less than 1-1/2 inches (38 mm), through stone masonry and with at least 5/8-inch cover on outside face.
- D. Space anchors to provide not less than 1 anchor per 2 sq. ft. of wall area. Install additional anchors within 12 inches of openings, sealant joints, and perimeter at intervals not exceeding 12 inches.
- E. Set stone in full bed of mortar with full head joints unless otherwise indicated. Build anchors into mortar joints as stone is set.
- F. Provide 1-inch or 2-inch cavity as indicated on Drawings between stone masonry and backup construction unless otherwise indicated. Keep cavity free of mortar droppings and debris.
  - 1. Place mortar spots in cavity at veneer anchors to maintain spacing.
  - 2. Slope beds toward cavity to minimize mortar protrusions into cavity.
  - 3. Do not attempt to trowel or remove mortar fins protruding into cavity.

- G. Rake out joints for pointing with mortar to depth of not less than 3/4 inch before setting mortar has hardened. Rake joints to uniform depths with square bottoms and clean sides.

### **3.7 STONE STAIR TREAD INSTALLATION**

- A. Place mortar bed over steel stair pan. Spread, tamp and screed to uniform thickness at elevations required for setting stone to finished elevations indicated.
- B. Mix and place only that amount of mortar bed that can be covered with stone before initial set. Cut back, bevel edge, and discard material that has reached initial set before stone can be placed.
- C. Place stone before initial set of mortar occurs. Immediately before placing stone on setting bed, apply uniform 1/16-inch- thick bond coat to bed or to back of each stone unit.
- D. Tamp and beat stone with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each unit in a single operation before initial set of mortar; do not return to areas already set and disturb stone for purposes of realigning finished surfaces or adjusting joints.
- E. Rake out joints to depth required to receive pointing mortar as units are set. Finished grout joint under stone tread between stone and steel pan should be raked back 1/2 inch typical.
- F. Point joints after setting. Fill full with mortar type and color indicated. Tool RECESSED joints flat, uniform, and smooth, without visible voids or bumps.

### **3.8 GROUTING**

- A. Grout stone joints to comply with ANSI A108.10 and with manufacturer's written instructions.
  - 1. Grout joints as soon as possible after initial set of setting bed. Force grout into joints, taking care not to smear grout on adjoining stone and other surfaces. After initial set of grout, finish joints by tooling to produce a slightly concave polished joint, free of drying cracks.
- B. Grout stone joints with water-cleanable epoxy grout to comply with ANSI A108.6 and with manufacturer's written instructions.

### **3.9 ADJUSTING AND CLEANING**

- A. Remove and replace stone masonry of the following description:
  - 1. Broken, chipped, stained, or otherwise damaged stone. Stone may be repaired if methods and results are approved by Architect.
  - 2. Defective joints.
  - 3. Stone masonry not matching approved samples and mockups.
  - 4. Stone masonry not complying with other requirements indicated.
- B. Replace in a manner that results in stone masonry matching approved samples and mockups, complying with other requirements, and showing no evidence of replacement.
- C. In-Progress Cleaning: Clean stone masonry as work progresses. Remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean stone masonry as follows:
  - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on mockup; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before cleaning stone masonry.
3. Wet wall surfaces with water before applying cleaner; remove cleaner promptly by rinsing thoroughly with clear water.
4. Clean stone masonry by bucket and brush hand-cleaning method described in BIA Technical Note No. 20 Revised II, using job-mixed detergent solution.

### **3.10 PROTECTION**

- A. Prohibit traffic from installed stone for a minimum of 72 hours.
- B. Protect installed stonework during construction with nonstaining kraft paper. Where adjoining areas require construction work access, cover stonework with a minimum of 3/4-inch untreated plywood over nonstaining kraft paper.

### **3.11 EXCESS MATERIALS AND WASTE**

- A. Excess Stone: Stack excess stone where directed by Owner for Owner's use.
- B. Disposal as Fill Material: Dispose of clean masonry waste, including mortar and excess or soil-contaminated sand, by crushing and mixing with fill material as fill is placed.
  1. Crush masonry waste to less than 4 inches in greatest dimension.
  2. Mix masonry waste with at least two parts of specified fill material for each part of masonry waste. Fill material is specified in Division 31 Sections.
  3. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other waste, and legally dispose of off Owner's property.

**END OF SECTION 04 43 00**

## **SECTION 04 72 00 - CAST STONE MASONRY**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Cast-stone veneer.
- B. Related Sections:
  - 1. Division 04 Section "Unit Masonry" for horizontal joint reinforcement.
  - 2. Division 07 Section "Sheet Metal Flashing and Trim" for concealed and exposed sheet metal flashing.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. For cast-stone units, include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: Show fabrication and installation details for cast-stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.
  - 1. Include building elevations showing layout of units and locations of joints and anchors.
- C. Samples for Initial Selection: For colored mortar.
- D. Samples for Verification:
  - 1. For each color and texture of cast stone required, 10 inches square in size.
    - a. Cast stone will be required to match Architect's color samples.
    - b. Multiple samples showing the possible range of colors will be required.
  - 2. For colored mortar, make Samples using same sand and mortar ingredients to be used on Project. Label Samples to indicate types and amounts of pigments used.
- E. Full-Size Samples: For each color and texture of cast-stone unit required.
  - 1. Make available for Architect's review at Project site.
  - 2. Make Samples from materials to be used for units used on Project immediately before beginning production of units for Project.
  - 3. Approved Samples may be installed in the Work.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For manufacturer and testing agency.
  - 1. Include copies of material test reports for completed projects, indicating compliance of cast stone with ASTM C1364.
- B. Material Test Reports: For each mix required to produce cast stone, based on testing according to ASTM C1364, including test for resistance to freezing and thawing.
  - 1. Provide test reports based on testing within previous two years.

## **1.5 QUALITY ASSURANCE**

- A. **Manufacturer Qualifications:** A qualified manufacturer of cast-stone units similar to those indicated for this Project, that has sufficient production capacity to manufacture required units, and is a plant certified by the Cast Stone Institute.
- B. **Testing Agency Qualifications:** Qualified according to ASTM E329 for testing indicated.
- C. **Mockups:** Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Materials in this section will be part of a freestanding mockup, see Drawing Sheet A0.60.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Coordinate delivery of cast stone to avoid delaying the Work and to minimize the need for on-site storage.
- B. Pack, handle, and ship cast-stone units in suitable packs or pallets.
  - 1. Lift with wide-belt slings; do not use wire rope or ropes that might cause staining. Move cast-stone units if required, using dollies with wood supports.
  - 2. Store cast-stone units on wood skids or pallets with nonstaining, waterproof covers, securely tied. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.
- C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- D. Store mortar aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

## **1.7 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. Comply with cold-weather construction requirements in TMS 602/ACI 530.1/ASCE 6.
  - 1. **Cold-Weather Cleaning:** Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until cast stone has dried, but no fewer than seven days after completing cleaning.
- B. **Hot-Weather Requirements:** Comply with hot-weather construction requirements in TMS 602/ACI 530.1/ASCE 6.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. **Source Limitations for Cast Stone:** Obtain cast-stone units from single source from single manufacturer.
- B. **Source Limitations for Mortar Materials:** Obtain mortar ingredients of a uniform quality, including color, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

### **2.2 CAST-STONE MATERIALS**

- A. **General:** Comply with ASTM C1364.

- B. Portland Cement: ASTM C150/C150M, Type I or Type III, containing not more than 0.60 percent total alkali when tested according to ASTM C114. Provide natural color or white cement as required to produce cast-stone color indicated.
- C. Coarse Aggregates: Granite, quartz, or limestone complying with ASTM C33/C33M; gradation and colors as needed to produce required cast-stone textures and colors.
- D. Fine Aggregates: Natural sand or crushed stone complying with ASTM C33/C33M, gradation and colors as needed to produce required cast-stone textures and colors.
- E. Color Pigment: ASTM C979/C979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
- F. Admixtures: Use only admixtures specified or approved in writing by Architect.
  - 1. Do not use admixtures that contain more than 0.1 percent water-soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.
  - 2. Use only admixtures that are certified by manufacturer to be compatible with cement and other admixtures used.
  - 3. Air-Entraining Admixture: ASTM C260/C260M. Add to mixes for units exposed to the exterior at manufacturer's prescribed rate to result in an air content of 4 to 6 percent, except do not add to zero-slump concrete mixes.
  - 4. Water-Reducing Admixture: ASTM C494/C494M, Type A.
  - 5. Water-Reducing, Retarding Admixture: ASTM C494/C494M, Type D.
  - 6. Water-Reducing, Accelerating Admixture: ASTM C494/C494M, Type E.
- G. Reinforcement: Deformed steel bars complying with ASTM A615/A615M, Grade 60. Use galvanized or epoxy-coated reinforcement when covered with less than 1-1/2 inches of cast-stone material.
  - 1. Epoxy Coating: ASTM A775/A775M.
  - 2. Galvanized Coating: ASTM A767/A767M.
- H. Embedded Anchors and Other Inserts: Fabricated from stainless steel complying with ASTM A240/A240M, ASTM A276, or ASTM A666, Type 304.

### **2.3 CAST-STONE UNITS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Continental Cast Stone East; Russell, Inc.
  - 2. Hoyle Stone Products
  - 3. Olde World Cast Stone
  - 4. Sun Precast Co., Inc. Cast-Stone Units: Comply with ASTM C1364.
  - 5. Or approved equivalent.
- B. Units shall be manufactured using either the vibrant dry tamp or wet-cast method.
  - 1. Units shall be resistant to freezing and thawing as determined by laboratory testing according to ASTM C666/C666M, Procedure A, as modified by ASTM C1364.
- C. Fabricate units with sharp arris and accurately reproduced details, with indicated texture on all exposed surfaces unless otherwise indicated.
  - 1. Slope exposed horizontal surfaces 1:12 to drain unless otherwise indicated.
  - 2. Provide raised fillets at backs of sills and at ends indicated to be built into jambs.
  - 3. Provide drips on projecting elements unless otherwise indicated.
- D. Provide L-shaped corner pieces as depicted in the Drawings.
- E. Fabrication Tolerances:

1. Variation in Cross Section: Do not vary from indicated dimensions by more than 1/8 inch.
  2. Variation in Length: Do not vary from indicated dimensions by more than 1/360 of the length of unit or 1/8 inch, whichever is greater, but in no case by more than 1/4 inch.
  3. Warp, Bow, and Twist: Not to exceed 1/360 of the length of unit or 1/8 inch, whichever is greater.
  4. Location of Grooves, False Joints, Holes, Anchorages, and Similar Features: Do not vary from indicated position by more than 1/8 inch on formed surfaces of units and 3/8 inch on unformed surfaces.
- F. Cure Units as Follows:
1. Cure units in enclosed, moist curing room at 95 to 100 percent relative humidity and temperature of 100 deg F for 12 hours or 70 deg F for 16 hours.
  2. Keep units damp and continue curing to comply with one of the following:
    - a. No fewer than five days at mean daily temperature of 70 deg F or above.
    - b. No fewer than six days at mean daily temperature of 60 deg F or above.
    - c. No fewer than seven days at mean daily temperature of 50 deg F or above.
    - d. No fewer than eight days at mean daily temperature of 45 deg F or above.
- G. Acid etch units after curing to remove cement film from surfaces to be exposed to view.
- H. Colors and Textures: As selected by Architect from manufacturer's full range.

## 2.4 MORTAR MATERIALS

- A. Provide mortar materials that comply with Division 04 Section "Unit Masonry."
- B. Portland Cement: ASTM C150/C150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- C. Hydrated Lime: ASTM C207, Type S.
- D. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- E. Do not use masonry or mortar cement in mortar.
- F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C979/C979M. Use only pigments with a record of satisfactory performance in masonry mortar.
- G. Aggregate for Mortar: ASTM C144.
  1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
  2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
  3. White-Mortar Aggregates: Natural white sand or crushed white stone.
  4. Colored Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- H. Water: Potable.

## 2.5 ACCESSORIES

- A. Anchors: Type and size indicated, fabricated from Type 304 stainless steel complying with ASTM A240/A240M, ASTM A276, or ASTM A666.



- B. Dowels: 1/2-inch-diameter round bars, fabricated from Type 304 stainless steel complying with ASTM A240/A240M, ASTM A276, or ASTM A666.
- C. Concealed Sheet Metal Flashing: Fabricated from stainless steel in thicknesses indicated, but not less than 0.0156 inch (0.4 mm) thick and complying with Division 07 Section "Sheet Metal Flashing and Trim."
- D. Weep and Vent Tubes: Rectangular, cellular, polypropylene or clear butyrate extrusion, 3/8 by 1-1/2 inches (9 by 38 mm), of length required to extend from exterior face of stone to cavity behind.
- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
  - 1. Manufacturer and Type: CavClear Masonry Mat as manufactured by Archovations, Inc., or approved equivalent.
  - 2. Description: Full-height Air Space Maintenance and Cavity Drainage Mat. The masonry drainage mat shall be specifically designed for masonry cavities to prevent mortar from making contact with the backup and ensure water management. The masonry drainage mat shall be fluid conducting, non-absorbent, mold and mildew resistant polymer mesh consisting of 100% recycled plastic with binder fibers. Masonry drainage mat is to be a non-woven textile product in random pattern and have voids no greater than 1/4" in diameter. Masonry mat is to be designed for substantially continuous installation behind the full-height of all masonry.
  - 3. Masonry Drainage Mat Thickness: 3/4 inches to allow no more than 3/8 inch tolerance between the masonry mat and masonry wythe.
- F. Asphalt Dampproofing: Cut-back asphalt complying with ASTM D 4479, Type I or asphalt emulsion complying with ASTM D 1227, Type III or IV.
- G. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cast-stone manufacturer and expressly approved by cleaner manufacturer for use on cast stone and adjacent masonry materials.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Diedrich Technologies, Inc.; a Hohmann & Barnard company.
    - b. EaCo Chem, Inc.
    - c. PROSOCO, Inc
    - d. Or approved equivalent.

## 2.6 MORTAR MIXES

- A. Comply with requirements in Division 4 Section "Unit Masonry" for mortar mixes.
- B. Do not use admixtures including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
  - 1. Do not use calcium chloride in mortar or grout.
  - 2. Use portland cement-lime mortar unless otherwise indicated.
- C. Comply with ASTM C270, Proportion Specification.
  - 1. For setting mortar, use Type N.
  - 2. For pointing mortar, use Type N.
- D. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.

1. Mix to match Architect's sample.
2. Application: Use colored-aggregate mortar for exposed mortar joints.

## **2.7 SOURCE QUALITY CONTROL**

- A. Engage a qualified independent testing agency to sample and test cast-stone units according to ASTM C1364.
  1. Include one test for resistance to freezing and thawing.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 SETTING CAST STONE IN MORTAR**

- A. Install cast-stone units to comply with requirements in Division 04 Section "Unit Masonry."
- B. Set cast stone as indicated on Drawings. Set units accurately in locations indicated, with edges and faces aligned according to established relationships and indicated tolerances.
  1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.
  2. Coordinate installation of cast stone with installation of flashing specified in other Sections.
- C. Coat back (cavity) side of cast stone with dampproofing material. Before backfilling, coat exterior face of cast stone to within 2" of finished grade.
- D. Wet joint surfaces thoroughly before applying mortar or setting in mortar.
- E. Set units in full bed of mortar with full head joints unless otherwise indicated.
  1. Set units with joints 1/4 to 3/8 inch wide unless otherwise indicated.
  2. Build anchors and ties into mortar joints as units are set.
  3. Fill dowel holes and anchor slots with mortar.
  4. Fill collar joints solid as units are set.
  5. Build concealed flashing into mortar joints as units are set.
  6. Keep head joints in copings and between other units with exposed horizontal surfaces open to receive sealant.
  7. Keep joints at shelf angles open to receive sealant.
- F. Rake out joints for pointing with mortar to depths of not less than 3/4 inch. Rake joints to uniform depths with square bottoms and clean sides. Scrub faces of units to remove excess mortar as joints are raked.
- G. Point mortar joints by placing and compacting mortar in layers not greater than 3/8 inch. Compact each layer thoroughly and allow it to become thumbprint hard before applying next layer.
- H. Tool exposed joints slightly concave when thumbprint hard. Use a smooth plastic jointer larger than joint thickness.
- I. Provide sealant joints at head joints of copings and other horizontal surfaces; at expansion, control, and pressure-relieving joints; and at locations indicated.
  1. Keep joints free of mortar and other rigid materials.

2. Build in compressible foam-plastic joint fillers where indicated.
3. Form joint of width indicated, but not less than 3/8 inch.
4. Prime cast-stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant unless otherwise indicated.
5. Prepare and apply sealant of type and at locations indicated to comply with applicable requirements in Division 07 Section "Joint Sealants."

### **3.3 INSTALLATION TOLERANCES**

- A. Variation from Plumb: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
- B. Variation from Level: Do not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
- C. Variation in Joint Width: Do not vary joint thickness more than 1/8 inch in 36 inches or one-fourth of nominal joint width, whichever is less.
- D. Variation in Plane between Adjacent Surfaces (Lipping): Do not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than 1/16 inch, except where variation is due to warpage of units within tolerances specified.

### **3.4 ADJUSTING AND CLEANING**

- A. Remove and replace stained and otherwise damaged units and units not matching approved Samples. Cast stone may be repaired if methods and results are approved by Architect.
  1. Replace units in a manner that results in cast stone matching approved Samples, complying with other requirements, and showing no evidence of replacement.
- B. In-Progress Cleaning: Clean cast stone as work progresses.
  1. Remove mortar fins and smears before tooling joints.
  2. Remove excess sealant immediately, including spills, smears, and spatter.
- C. Final Cleaning: After mortar is thoroughly set and cured, clean exposed cast stone as follows:
  1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
  2. Test cleaning methods on sample; leave one sample uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of cast stone.
  3. Protect adjacent surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
  4. Wet surfaces with water before applying cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
  5. Clean cast stone by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
  6. Clean cast stone with proprietary acidic cleaner applied according to manufacturer's written instructions.

### **3.5 MASONRY WASTE DISPOSAL**

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Waste Disposal as Fill Material: Dispose of clean masonry waste, including excess or soilcontaminated sand, waste mortar, and broken masonry units, by crushing and mixing with fill material as fill is placed.
  1. Crush masonry waste to less than 4 inches in each dimension.
  2. Mix masonry waste with at least two parts of specified fill material for each part of

3. masonry waste. Fill material is specified in Division 31 Section "Earthworks."
  4. Do not dispose of masonry waste as fill within 18 inches of finished grade.
- C. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

**END OF SECTION 04 72 00**

## **SECTION 05 12 00 - STRUCTURAL STEEL FRAMING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Structural steel.
  - 2. Field-installed shear connectors.
  - 3. Grout.
- B. Related Requirements:
  - 1. Division 05 Section "Steel Decking" for field installation of shear connectors through deck.
  - 2. Division 05 Section "Metal Fabrications" for miscellaneous steel fabrications and other steel items not defined as structural steel.
  - 3. Division 09 Section "Painting" for surface-preparation and priming requirements.

#### **1.3 DEFINITIONS**

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- B. Heavy Sections: Rolled and built-up sections as follows:
  - 1. Shapes included in ASTM A6/A6M with flanges thicker than 1-1/2 inches.
  - 2. Welded built-up members with plates thicker than 2 inches.
  - 3. Column base plates thicker than 2 inches.

#### **1.4 COORDINATION**

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

#### **1.5 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.6 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication of structural-steel components.
  - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
  - 2. Include embedment Drawings.
  - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.

4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections.
  5. Identify members and connections of the Seismic-Load-Resisting System.
  6. Indicate locations and dimensions of protected zones.
  7. Identify demand critical welds.
- C. Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for each welded joint whether prequalified, including the following:
1. Power source (constant current or constant voltage).
  2. Electrode manufacturer and trade name, for demand critical welds.
- D. Delegated-Design Submittal: For structural-steel connections indicated to comply with design loads, include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.7 **INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer, fabricator and testing agency.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Mill test reports for structural steel, including chemical and physical properties.
- E. Product Test Reports: For the following:
1. Bolts, nuts, and washers including mechanical properties and chemical analysis.
  2. Direct-tension indicators.
  3. Tension-control, high-strength, bolt-nut-washer assemblies.
  4. Shear stud connectors.
  5. Shop primers.
  6. Nonshrink grout.
- F. Survey of existing conditions.
- G. Source quality-control reports.
- H. Field quality-control and special inspection reports.

#### 1.8 **QUALITY ASSURANCE**

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.
- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1 or to SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
- D. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
1. Welders and welding operators performing work on bottom-flange, demand-critical welds shall pass the supplemental welder qualification testing, as required by

AWS D1.8/D1.8M. FCAW-S and FCAW-G shall be considered separate processes for welding personnel qualification.

- E. Comply with applicable provisions of the following specifications and documents:
  1. AISC 303.
  2. AISC 341 and AISC 341s1.
  3. AISC 360.
  4. RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts."

F. Products in this section may be used in free-standing mockups.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
  1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
  1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
  2. Clean and relubricate bolts and nuts that become dry or rusty before use.
  3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F3125/F3125M, Grade F1852 bolt assemblies and for retesting bolt assemblies after lubrication.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Connections: Provide details of simple shear connections required by the Contract Documents to be selected or completed by structural-steel fabricator, including comprehensive engineering analysis by a qualified professional engineer, to withstand loads indicated and comply with other information and restrictions indicated.
  1. Select and complete connections using schematic details indicated and AISC 360.
  2. Use Load and Resistance Factor Design; data are given at factored-load level.
- B. Moment Connections: Type FR, fully restrained.

### 2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A992/A992M.
- B. Channels, Angles: ASTM A36/A36M.
- C. Plate and Bar: ASTM A36/A36M or ASTM A572/A572M, Grade 50, see plans.
- D. Cold-Formed Hollow Structural Sections: ASTM A500/A500M, Grade B, structural tubing.
- E. Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B.
  1. Weight Class: Standard, Extra strong or Double-extra strong; see plans.
  2. Finish: Black except where indicated to be galvanized.
- F. Steel Castings: ASTM A216/A216M, Grade WCB with supplementary requirement S11.
- G. Steel Forgings: ASTM A668/A668M.

- H. Welding Electrodes: Comply with AWS requirements.

## 2.3 **BOLTS, CONNECTORS, AND ANCHORS**

- A. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
  - 1. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with plain finish.
- B. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A490, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers; all with plain finish.
  - 1. Direct-Tension Indicators: ASTM F959/F959M, Type 490-1, compressible-washer type with plain finish.
- C. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
  - 1. Finish: Hot-dip or mechanically deposited zinc coating.
  - 2. Direct-Tension Indicators: ASTM F959/F959M, Type 325-1, compressible-washer type with mechanically deposited zinc coating finish.
- D. Tension-Control, High-Strength Bolt-Nut-Washer Assemblies: ASTM F3125/F3125M, Grade F1852, Type 1, heavy-hex head assemblies consisting of steel structural bolts with splined ends; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436/F436M, Type 1, hardened carbon-steel washers.
  - 1. Finish: Plain or Mechanically deposited zinc coating.
- E. Shear Connectors: ASTM A108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
- F. Unheaded Anchor Rods: ASTM F1554, Grade 55, weldable.
  - 1. Configuration: Straight.
  - 2. Nuts: ASTM A563 heavy-hex carbon steel.
  - 3. Plate Washers: ASTM A36/A36M carbon steel.
  - 4. Washers: ASTM F436, Type 1, hardened carbon steel.
  - 5. Finish: Hot-dip zinc coating, ASTM A153/A153M, Class C.
- G. Threaded Rods: ASTM A36/A36M or ASTM A572/A572M, Grade 50.
  - 1. Nuts: ASTM A563 heavy-hex carbon steel.
  - 2. Washers: ASTM F436, Type 1, hardened carbon steel.
  - 3. Finish: Plain or Hot-dip zinc coating, ASTM A153/A153M, Class C.

## 2.4 **PRIMER**

- A. Comply with Division 07 Section "Fluid Applied Insulation Coating" where applicable.
- B. Primer: Comply with Division 09 Section "Painting."

## 2.5 **GROUT**

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.



## 2.6 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.
  - 1. Identify high-strength structural steel according to ASTM A6/A6M and maintain markings until structural steel has been erected.
  - 2. Mark and match-mark materials for field assembly.
  - 3. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
  - 1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1/D1.1M.
- C. Bolt Holes: Cut, drill or punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 3, "Power Tool Cleaning."
- F. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.
- G. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
  - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
  - 2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
  - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.
- H. Security Gate Support Steel:
  - 1. Fabricate supports for security gates as recommended by partition manufacturer. Drill or punch bottom flanges of beams to receive partition track hanger rods; locate holes where indicated on operable partition shop drawings.

## 2.7 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts" for type of bolt and type of joint specified.
  - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
  - 1. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.

## 2.8 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
  - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.

2. Surfaces to be field welded.
  3. Surfaces of high-strength bolted, slip-critical connections.
  4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
  5. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
1. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- C. Comply with Division 07 Section "Fluid Applied Insulation Coating" where applicable.
- D. Priming and Painting: See Division 09 Section "Painting"

## 2.9 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A123/A123M.
1. Fill vent and drain holes that are exposed in the finished Work unless they function as weep holes, by plugging with zinc solder and filing off smooth.
  2. Galvanize attached to structural-steel frame and located in exterior walls as noted on plans.

## 2.10 SOURCE QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform shop tests and inspections.
1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Bolted Connections: Inspect shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts."
- C. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
1. Liquid Penetrant Inspection: ASTM E165.
  2. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
  3. Ultrasonic Inspection: ASTM E164.
  4. Radiographic Inspection: ASTM E94.
- D. In addition to visual inspection, test and inspect shop-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
  2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.
- E. Prepare test and inspection reports.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of existing conditions. Include bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.
1. Do not remove temporary shoring supporting composite deck construction until cast-in-place concrete has attained its design compressive strength.

### 3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Baseplates and Leveling Plates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
1. Set plates for structural members on wedges, shims, or setting nuts as required.
  2. Weld plate washers to top of baseplate.
  3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
  4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members that form part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that are in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
1. Level and plumb individual members of structure.
  2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Do not use thermal cutting during erection unless approved by Architect. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.
- G. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.
- H. Shear Connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to AWS D1.1/D1.1M and manufacturer's written instructions.

### 3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts" for type of bolt and type of joint specified.

1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
  1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
  2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
  3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

### 3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
  1. Verify structural-steel materials and inspect steel frame joint details.
  2. Verify weld materials and inspect welds.
  3. Verify connection materials and inspect high-strength bolted connections.
- B. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- C. Bolted Connections: Inspect bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A325 or A 490 Bolts."
- D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.
  1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
    - a. Liquid Penetrant Inspection: ASTM E165.
    - b. Magnetic Particle Inspection: ASTM E709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
    - c. Ultrasonic Inspection: ASTM E164.
    - d. Radiographic Inspection: ASTM E94.
- E. In addition to visual inspection, test and inspect field-welded shear connectors according to requirements in AWS D1.1/D1.1M for stud welding and as follows:
  1. Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector.
  2. Conduct tests according to requirements in AWS D1.1/D1.1M on additional shear connectors if weld fracture occurs on shear connectors already tested.

### 3.6 REPAIRS AND PROTECTION

- A. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A780/A780M.
- B. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged or missing and paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
  1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
- C. Touchup Painting: Cleaning and touchup painting are specified in Division 09 Section "Painting."

**END OF SECTION 05 12 00**

## **SECTION 05 31 00 - STEEL DECKING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Roof deck.
  - 2. Composite floor deck.
- B. Related Requirements:
  - 1. Division 03 Section "Cast-in-Place Concrete" for normal-weight and lightweight structural concrete fill over steel deck.
  - 2. Division 05 Section "Structural Steel Framing" for shop- and field-welded shear connectors.
  - 3. Division 05 Section "Metal Fabrications" for framing deck openings with miscellaneous steel shapes.
  - 4. Division 09 Section "Painting" for repair painting of primed deck and finish painting of deck.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of deck, accessory, and product indicated.
- B. Shop Drawings:
  - 1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories, and attachments to other construction.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Welding certificates.
- B. Product Certificates: For each type of steel deck.
- C. Product Test Reports: For tests performed by a qualified testing agency, indicating that each of the following complies with requirements:
  - 1. Powder-actuated mechanical fasteners.
- D. Evaluation Reports: For steel deck, from ICC-ES.
- E. Field quality-control reports.

#### **1.5 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
- C. FM Global Listing: Provide steel roof deck evaluated by FM Global and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

- D. Products from this section may be used in freestanding mockups.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect steel deck from corrosion, deformation, and other damage during delivery, storage, and handling.
- B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.
  - 1. Protect and ventilate acoustical cellular roof deck with factory-installed insulation to maintain insulation free of moisture.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. AISI Specifications: Comply with calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."
- B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

### 2.2 ROOF DECK

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Canam Steel Corporation; Canam Group, Inc.
  - 2. Epic Metals Corporation.
  - 3. New Millennium Building Systems, LLC.
  - 4. Nucor Corp.
  - 5. Or approved equivalent.
- B. Roof Deck: Fabricate panels, without top-flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:
  - 1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), G60 zinc coating.
  - 2. Deck Profile: As indicated.
  - 3. Profile Depth: As indicated.
  - 4. Design Uncoated-Steel Thickness: As indicated.
  - 5. Span Condition: Triple span or more.
  - 6. Side Laps: Overlapped or interlocking seam at Contractor's option.
  - 7. Or approved equivalent.

### 2.3 COMPOSITE FLOOR DECK

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Canam Steel Corporation; Canam Group, Inc.
  - 2. Epic Metals Corporation.
  - 3. New Millennium Building Systems, LLC.
  - 4. Nucor Corp.
  - 5. Or approved equivalent.
- B. Composite Floor Deck: Fabricate panels, with integrally embossed or raised pattern ribs and interlocking side laps, to comply with "SDI Specifications and Commentary for Composite Steel

Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:

1. Galvanized-Steel Sheet: ASTM A653/A653M, Structural Steel (SS), Grade 33, G60 zinc coating.
2. Profile Depth: As indicated.
3. Design Uncoated-Steel Thickness: As indicated.
4. Span Condition: Triple span or more.

## 2.4 ACCESSORIES

- A. General: Provide manufacturer's standard accessory materials for deck that comply with requirements indicated.
- B. Mechanical Fasteners: Corrosion-resistant, low-velocity, powder-actuated or pneumatically driven carbon-steel fasteners; or self-drilling, self-threading screws.
- C. Side-Lap Fasteners: Corrosion-resistant, hexagonal washer head; self-drilling, carbon-steel screws, No. 10 minimum diameter.
- D. Flexible Closure Strips: Vulcanized, closed-cell, synthetic rubber.
- E. Miscellaneous Sheet Metal Deck Accessories: Steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359-inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.
- F. Pour Stops and Girder Fillers: Steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth.
- G. Column Closures, End Closures, Z-Closures, and Cover Plates: Steel sheet, of same material, finish, and thickness as deck unless otherwise indicated.
- H. Weld Washers: Uncoated steel sheet, shaped to fit deck rib, 0.0598 inch thick, with factory-punched hole of 3/8-inch minimum diameter.
- I. Flat Sump Plates: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck. For drains, cut holes in the field.
- J. Recessed Sump Pans: Single-piece steel sheet, 0.0747 inch thick, of same material and finish as deck, with 3-inch-wide flanges and sloped recessed pans of 1-1/2-inch minimum depth. For drains, cut holes in the field.
- K. Galvanizing Repair Paint: ASTM A780/A780M.
- L. Repair Paint: Manufacturer's standard rust-inhibitive primer of same color as primer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 **INSTALLATION, GENERAL**

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, manufacturer's written instructions, and requirements in this Section.
- B. Install temporary shoring before placing deck panels if required to meet deflection limitations.
- C. Locate deck bundles to prevent overloading of supporting members.
- D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side-lap interlocks.
  - 1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.
- E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.
- G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck, and support of other work.
- H. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
- I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.

### 3.3 **ROOF-DECK INSTALLATION**

- A. Fasten roof-deck panels to steel supporting members with mechanical fasteners as follows:
  - 1. Hilti Direct Fasteners: X-ENP-19 L15
  - 2. Fastener Pattern: 36/4
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 18 inches, and as follows:
  - 1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
  - 2. Mechanically fasten with Hilti S-SLC 02 MHW fasteners.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
  - 1. End Joints: Lapped 2 inches minimum or butted at Contractor's option.
- D. Roof Sump Pans and Sump Plates: Install over openings provided in roof deck and weld or mechanically fasten flanges to top of deck. Space welds or mechanical fasteners not more than 12 inches apart with at least one weld] fastener at each corner.
  - 1. Install reinforcing channels or zees in ribs to span between supports and weld or mechanically fasten.
- E. Miscellaneous Roof-Deck Accessories: Install ridge and valley plates, finish strips, end closures, and reinforcing channels according to deck manufacturer's written instructions. Mechanically fasten to substrate to provide a complete deck installation.
- F. Flexible Closure Strips: Install flexible closure strips over partitions, walls, and where indicated. Install with adhesive according to manufacturer's written instructions to ensure complete closure.



### 3.4 FLOOR-DECK INSTALLATION

- A. Fasten floor-deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:
  - 1. Weld Diameter: 3/4 inch, nominal.
  - 2. Weld Spacing: Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart.
  - 3. Weld Spacing: Space and locate welds as indicated.
  - 4. Weld Washers: Install weld washers at each weld location.
- B. Side-Lap and Perimeter Edge Fastening: Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of one-half of the span or 36 inches, and as follows:
  - 1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon-steel screws.
  - 2. Mechanically clinch or button punch.
  - 3. Fasten with a minimum of 1-1/2-inch-long welds.
- C. End Bearing: Install deck ends over supporting frame with a minimum end bearing of 1-1/2 inches, with end joints as follows:
  - 1. End Joints: Lapped or butted at Contractor's option.
- D. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.
- E. Floor-Deck Closures: Weld steel sheet column closures, cell closures, and Z-closures to deck, according to SDI recommendations, to provide tight-fitting closures at open ends of ribs and sides of deck.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Field welds will be subject to inspection.
- C. Prepare test and inspection reports.

### 3.6 PROTECTION

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.
- B. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.
  - 1. Apply repair paint, of same color as adjacent shop-primed deck, to bottom surfaces of deck exposed to view.
  - 2. Wire brushing, cleaning, and repair painting of bottom deck surfaces are included in Division 09 Section "Painting".
- C. Repair Painting: Wire brushing, cleaning, and repair painting of rust spots, welds, and abraded areas of both deck surfaces are included in Division 09 Section "Painting".

**END OF SECTION 05 31 00**

## **SECTION 05 40 00 - COLD-FORMED METAL FRAMING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Exterior load-bearing wall framing.
  - 2. Exterior non-load-bearing wall framing.
  - 3. Soffit framing.
- B. Related Requirements:
  - 1. Division 05 Section "Metal Fabrications" for miscellaneous steel shapes, masonry shelf angles, and connections used with cold-formed metal framing.
  - 2. Division 09 Section "Gypsum Board Shaft Wall Assemblies" for interior non-load-bearing, metal-stud-framed, shaft-wall assemblies, with height limitations.
  - 3. Division 09 Section "Non-Structural Metal Framing" for standard, interior non-load-bearing, metal-stud framing, with height limitations and ceiling-suspension assemblies.

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel framing; fabrication; and fastening and anchorage details, including mechanical fasteners.
  - 2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
- C. Delegated-Design Submittal: For cold-formed steel framing.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For testing agency.
- B. Welding certificates.
- C. Product Certificates: For each type of code-compliance certification for studs and tracks.
- D. Product Test Reports: For each listed product, for tests performed by manufacturer and witnessed by a qualified testing agency or performed by a qualified testing agency.
  - 1. Steel sheet.
  - 2. Expansion anchors.
  - 3. Power-actuated anchors.
  - 4. Mechanical fasteners.
  - 5. Vertical deflection clips.
  - 6. Horizontal drift deflection clips
  - 7. Miscellaneous structural clips and accessories.

- E. Evaluation Reports: For nonstandard cold-formed steel framing post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

## **1.6 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
- B. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment, indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
- C. Code-Compliance Certification of Studs and Tracks: Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association, the Steel Framing Industry Association or the Steel Stud Manufacturers Association.
- D. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
- E. Products in this section may be included in a freestanding mockup.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. ClarkDietrich.
  - 2. MarinoWARE.
  - 3. Nuconsteel, A Nucor Company.
  - 4. The Steel Network, Inc.
  - 5. United Metal Products, Inc.
  - 6. United Steel Deck, Inc.
  - 7. Or approved equivalent.

### **2.2 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design cold-formed steel framing.
- B. Structural Performance: Provide cold-formed steel framing capable of withstanding design loads within limits and under conditions indicated.
  - 1. Design Loads: Determined by specialty contractor's engineer based on criteria indicated on Drawings.
  - 2. Deflection Limits: Design framing systems to withstand calculated design loads without deflections greater than the following:
    - a. Exterior Load-Bearing Wall Framing: Horizontal deflection of 1/600 of the wall height or 0.25" maximum.
    - b. Exterior Non-Load-Bearing Framing: Horizontal deflection of 1/600 of the wall height.
  - 3. Design framing systems to provide for movement of framing members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F.

4. Design framing system to maintain clearances at openings, to allow for construction tolerances, and to accommodate live load deflection of primary building structure as follows:
    - a. Upward and downward movement of 1/2 inch
  5. Design exterior non-load-bearing wall framing to accommodate horizontal deflection without regard for contribution of sheathing materials.
- C. Cold-Formed Steel Framing Standards: Unless more stringent requirements are indicated, framing shall comply with AISI S100, AISI S200, and the following:
1. Wall Studs: AISI S211.
  2. Headers: AISI S212.
  3. Lateral Design: AISI S213.
- D. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency acceptable to authorities having jurisdiction.

### **2.3 COLD-FORMED STEEL FRAMING MATERIALS**

- A. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
1. Grade: ST33H or ST50H (As required by structural performance)
  2. Coating: G60, A60, AZ50, or GF30.
- B. Steel Sheet for Vertical Deflection Clips: ASTM A653/A653M, structural steel, zinc coated, of grade and coating as follows:
1. Grade: As required by structural performance.
  2. Coating: G60.

### **2.4 EXTERIOR LOAD-BEARING WALL FRAMING**

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch (18 gauge).
  2. Minimum Flange Width: 1-3/8 inches.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with straight flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0329 inch (20 gauge).
  2. Minimum Flange Width: 1-1/4 inches.
- C. Steel Box or Back-to-Back Headers: Manufacturer's standard C-shapes used to form header beams, of web depths indicated, unpunched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch (18 gauge).
  2. Minimum Flange Width: 1-3/8 inches.

### **2.5 EXTERIOR NON-LOAD-BEARING WALL FRAMING**

- A. Steel Studs: Manufacturer's standard C-shaped steel studs, of web depths indicated, punched, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0329 inch (20 gauge).
  2. Minimum Flange Width: 1-3/8 inches.
- B. Steel Track: Manufacturer's standard U-shaped steel track, of web depths indicated, unpunched, with unstiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0329 inch (20 gauge)

2. Minimum Flange Width: 1-1/4 inches.
- C. Vertical Deflection Clips: Manufacturer's standard bypass or head clips, capable of accommodating upward and downward vertical displacement of primary structure through positive mechanical attachment to stud web.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. ClarkDietrich.
    - b. MarinoWARE.
    - c. Simpson Strong-Tie Co., Inc.
    - d. The Steel Network, Inc.
    - e. Or approved equivalent.
- D. Single Deflection Track: Manufacturer's single, deep-leg, U-shaped steel track; unpunched, with unstiffened flanges, of web depth to contain studs while allowing free vertical movement, with flanges designed to support horizontal loads and transfer them to the primary structure, and as follows:
1. Minimum Base-Metal Thickness: 0.0428 inch (18 gauge).
  2. Flange Width: 1 inch plus the design gap for one-story structures and 1 inch plus twice the design gap for other applications.
- E. Drift Clips: Manufacturer's standard bypass or head clips, capable of isolating wall stud from upward and downward vertical displacement and lateral drift of primary structure through positive mechanical attachment to stud web and structure.

## **2.6 SOFFIT FRAMING**

- A. Exterior Soffit Frame: Manufacturer's standard C-shaped steel sections, of web depths indicated, with stiffened flanges, and as follows:
1. Minimum Base-Metal Thickness: 0.0329 inch (20 gauge).
  2. Minimum Flange Width: 1-5/8 inches.

## **2.7 FRAMING ACCESSORIES**

- A. Fabricate steel-framing accessories from ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for framing members.
- B. Provide accessories of manufacturer's standard thickness and configuration, unless otherwise indicated, as follows:
1. Supplementary framing.
  2. Bracing, bridging, and solid blocking.
  3. Web stiffeners.
  4. Anchor clips.
  5. End clips.
  6. Foundation clips.
  7. Gusset plates.
  8. Stud kickers and knee braces.
  9. Joist hangers and end closures.
  10. Hole-reinforcing plates.
  11. Backer plates.

## **2.8 ANCHORS, CLIPS, AND FASTENERS**

- A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.

- B. Anchor Bolts: ASTM F1554, Grade 55, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153/A153M, Class C.
- C. Post-Installed Anchors: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC193, ICC-ES AC58 or ICC-ES AC308 as appropriate for the substrate.
  - 1. Uses: Securing cold-formed steel framing to structure.
  - 2. Type: Torque-controlled expansion anchor or adhesive anchor.
  - 3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
  - 4. Material for Exterior or Interior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.
- D. Power-Actuated Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping, steel drill screws.
  - 1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.
- F. Welding Electrodes: Comply with AWS standards.

## **2.9 MISCELLANEOUS MATERIALS**

- A. Galvanizing Repair Paint: ASTM A780/A780M, MIL-P-21035B or SSPC-Paint 20.
- B. Cement Grout: Portland cement, ASTM C150/C150M, Type I; and clean, natural sand, ASTM C404. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.
- C. Nonmetallic, Nonshrink Grout: Factory-packaged, nonmetallic, noncorrosive, nonstaining grout, complying with ASTM C1107/C1107M, and with a fluid consistency and 30-minute working time.
- D. Shims: Load-bearing, high-density, multimonomer, nonleaching plastic; or cold-formed steel of same grade and metallic coating as framing members supported by shims.
- E. Sealer Gaskets: Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to match width of bottom track or rim track members as required.

## **2.10 FABRICATION**

- A. Fabricate cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
  - 1. Fabricate framing assemblies using jigs or templates.
  - 2. Cut framing members by sawing or shearing; do not torch cut.
  - 3. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator. Wire tying of framing members is not permitted.
    - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
    - b. Locate mechanical fasteners and install according to Shop Drawings, with screws penetrating joined members by no fewer than three exposed screw threads.

4. Fasten other materials to cold-formed steel framing by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.
- B. Reinforce, stiffen, and brace framing assemblies to withstand handling, delivery, and erection stresses. Lift fabricated assemblies by means that prevent damage or permanent distortion.
- C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet and as follows:
  1. Spacing: Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
  2. Squareness: Fabricate each cold-formed steel framing assembly to a maximum out-of-square tolerance of 1/8 inch.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, conditions, and abutting structural framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Before sprayed fire-resistive materials are applied, attach continuous angles, supplementary framing, or tracks to structural members indicated to receive sprayed fire-resistive materials.
- B. After applying sprayed fire-resistive materials, remove only as much of these materials as needed to complete installation of cold-formed framing without reducing thickness of fire-resistive materials below that required to obtain fire-resistance ratings indicated. Protect remaining fire-resistive materials from damage.
- C. Install load-bearing shims or grout between the underside of load-bearing wall bottom track and the top of foundation wall or slab at locations with a gap larger than 1/4 inch to ensure a uniform bearing surface on supporting concrete or masonry construction.
- D. Install sealer gaskets at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.

### **3.3 INSTALLATION, GENERAL**

- A. Cold-formed steel framing may be shop or field fabricated for installation, or it may be field assembled.
- B. Install cold-formed steel framing according to AISI S200, AISI S202, and manufacturer's written instructions unless more stringent requirements are indicated.
- C. Install shop- or field-fabricated, cold-formed framing and securely anchor to supporting structure.
  1. Screw, bolt, or weld wall panels at horizontal and vertical junctures to produce flush, even, true-to-line joints with maximum variation in plane and true position between fabricated panels not exceeding 1/16 inch.
- D. Install cold-formed steel framing and accessories plumb, square, and true to line, and with connections securely fastened.
  1. Cut framing members by sawing or shearing; do not torch cut.

2. Fasten cold-formed steel framing members by welding, screw fastening, clinch fastening, or riveting. Wire tying of framing members is not permitted.
  - a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
  - b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.
- E. Install framing members in one-piece lengths unless splice connections are indicated for track or tension members.
- F. Install temporary bracing and supports to secure framing and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to framing are secured.
- G. Install insulation, specified in Division 07 "Thermal Insulation," in framing-assembly members, such as headers, sills, boxed joists, and multiple studs at openings, that are inaccessible on completion of framing work.
- H. Fasten hole-reinforcing plate over web penetrations that exceed size of manufacturer's approved or standard punched openings.

### **3.4 EXTERIOR LOAD-BEARING WALL INSTALLATION**

- A. Install continuous top and bottom tracks sized to match studs. Align tracks accurately and securely anchor at corners and ends, and at spacings as follows:
  1. Anchor Spacing: 24 inches unless noted otherwise.
- B. Squarely seat studs against top and bottom tracks, with gap not exceeding 1/8 inch between the end of wall-framing member and the web of track. Fasten both flanges of studs to top and bottom tracks. Space studs as follows:
  1. Stud Spacing: 16 inches unless noted otherwise.
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar configurations.
- D. Align studs vertically where floor framing interrupts wall-framing continuity. Where studs cannot be aligned, continuously reinforce track to transfer loads.
- E. Anchor studs abutting structural columns or walls, including masonry walls, to supporting structure.
- F. Install headers over wall openings wider than stud spacing. Locate headers above openings. Fabricate headers of compound shapes indicated or required to transfer load to supporting studs, complete with clip-angle connectors, web stiffeners, or gusset plates.
  1. Frame wall openings with not less than a double stud at each jamb of frame. Fasten jamb members together to uniformly distribute loads.
  2. Install tracks and jack studs above and below wall openings. Anchor tracks to jamb studs with clip angles or by welding, and space jack studs same as full-height wall studs.
- G. Install supplementary framing, blocking, and bracing in stud framing indicated to support fixtures, equipment, services, casework, heavy trim, furnishings, and similar work requiring attachment to framing.
  1. If type of supplementary support is not indicated, comply with stud manufacturer's written recommendations and industry standards in each case, considering weight or load resulting from item supported.



- H. Install horizontal bridging in stud system, spaced vertically: as indicated on Shop Drawings. Fasten at each stud intersection.
  - 1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs with a minimum of two screws into each flange of the clip angle for framing members up to 6 inches deep.
  - 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges, and secure solid blocking to stud webs or flanges.
  - 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- I. Install miscellaneous framing and connections, including supplementary framing, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

### **3.5 EXTERIOR NON-LOAD-BEARING WALL INSTALLATION**

- A. Install continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.
- B. Fasten both flanges of studs to top and bottom track unless otherwise indicated. Space studs as follows:
  - 1. Stud Spacing: 16 inches unless noted otherwise
- C. Set studs plumb, except as needed for diagonal bracing or required for nonplumb walls or warped surfaces and similar requirements.
- D. Isolate non-load-bearing steel framing from building structure to prevent transfer of vertical loads while providing lateral support.
  - 1. Install single deep-leg deflection tracks and anchor to building structure.
  - 2. Connect vertical deflection clips to studs and anchor to building structure.
  - 3. Connect drift clips to cold-formed steel framing and anchor to building structure.
- E. Install horizontal bridging in wall studs, spaced vertically in rows indicated on Shop Drawings but not more than 48 inches apart. Fasten at each stud intersection.
  - 1. Channel Bridging: Cold-rolled steel channel, welded or mechanically fastened to webs of punched studs.
  - 2. Strap Bridging: Combination of flat, taut, steel sheet straps of width and thickness indicated and stud-track solid blocking of width and thickness to match studs. Fasten flat straps to stud flanges and secure solid blocking to stud webs or flanges.
  - 3. Bar Bridging: Proprietary bridging bars installed according to manufacturer's written instructions.
- F. Top Bridging for Single Deflection Track: Install row of horizontal bridging within 12 inches of single deflection track. Install a combination of bridging and stud or stud-track solid blocking of width and thickness matching studs, secured to stud webs or flanges.
  - 1. Install solid blocking at centers indicated on Shop Drawings.
- G. Install miscellaneous framing and connections, including stud kickers, web stiffeners, clip angles, continuous angles, anchors, and fasteners, to provide a complete and stable wall-framing system.

### **3.6 ERECTION TOLERANCES**

- A. Install cold-formed steel framing level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet and as follows:

1. Space individual framing members no more than plus or minus 1/8 inch from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

### **3.7 FIELD QUALITY CONTROL**

- A. Testing: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Field and shop welds will be subject to testing and inspecting.
- C. Testing agency will report test results promptly and in writing to Contractor and Architect.
- D. Cold-formed steel framing will be considered defective if it does not pass tests and inspections.
- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

### **3.8 REPAIRS AND PROTECTION**

- A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel framing with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel framing is without damage or deterioration at time of Substantial Completion.

### **3.9 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  1. Aluminum
  2. Steel
  3. Plastic Materials
  4. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 05 40 00**

## **SECTION 05 50 00 - METAL FABRICATIONS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  1. Steel framing and supports for security grille.
  2. Steel framing and supports for countertops.
  3. Steel framing and supports for mechanical and electrical equipment.
  4. Steel framing and supports for applications where framing and supports are not specified in other Sections.
  5. Steel shapes for supporting elevator door sills.
  6. Loose steel lintels and shelf angles.
  7. Metal ladders and ships' ladders.
  8. Ladder safety cages.
  9. Mechanical maintenance platform, ladder and ladder safety cage.
  10. Metal gratings and frames.
  11. Elevator pit and sewage ejector pit sump covers.
  12. Loose bearing and leveling plates for applications where they are not specified in other Sections.
  13. Safety railing system for roof, including guard rails with gates.
  14. Tieback anchors for roof safety.
  15. Loading dock stair railings.
  16. Overhead supports for side folding grilles not included in Division 05 Section "Structural Steel Framing."
- B. Products furnished, but not installed, under this Section include the following:
  1. Loose steel lintels.
  2. Anchor bolts, steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
  3. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.
- C. Related Requirements:
  1. Division 03 Section "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, slotted-channel inserts, wedge-type inserts, and other items cast into concrete.
  2. Division 04 Section "Unit Masonry" for installing loose lintels, anchor bolts, and other items built into unit masonry.
  3. Division 05 Section "Structural Steel Framing."
  4. Division 05 Section "Decorative Metal Stairs & Railings."
  5. Division 05 Section "Decorative Metal."
  6. Division 06 Section "Interior Architectural Woodwork" for countertops supported by metal fabrications.
  7. Division 32 Section "Plants" for tree grates.

#### **1.3 COORDINATION**

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.

- B. Coordinate installation of metal fabrications that are anchored to or that receive other work. 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.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For the following:
  - 1. Paint products.
  - 2. Grout.
- B. Shop Drawings: Show fabrication and installation details.
  - 1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
  - 2. Provide templates for anchors and bolts specified for installation in other Sections.
- C. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Submit calculations with shop drawings for concurrent review.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For professional engineer.
- B. Mill Certificates: Signed by stainless-steel manufacturers, certifying that products furnished comply with requirements.
- C. Welding certificates.
- D. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- E. Research/Evaluation Reports: For post-installed anchors, from ICC-ES.

#### **1.6 QUALITY ASSURANCE**

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
  - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."
- C. Metal Bar Grating Standards: Comply with NAAMM MBG 531, "Metal Bar Grating Manual."

#### **1.7 FIELD CONDITIONS**

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Engage a qualified professional engineer, as defined in Division 1 Section "Quality Requirements," to design ladders, gratings, grating frames, mechanical maintenance platform, guard rails, ships ladder and cages and roof safety systems.
  - 1. Safety anchor system design shall comply with current OSHA, ANSI, and local building code, mechanical code, and regulations pertaining to fall protection.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- C. Safety anchor system design shall comply with current OSHA, ANSI, and local regulations pertaining to fall protection.
  - 1. Structural design requirements of anchorages and tie-back
    - a. Anchorage shall be capable of sustaining a minimum ultimate load of 5,000 lbs., in any direction the load may be applied, without fracture or failure.
    - b. Anchorage shall be capable of sustaining a minimum proof load of 2,500 lbs., in any direction the load may be applied, without permanent deformation or damage to anchorage.
    - c. Anchorages shall be designed with a minimum 1,250 lb. working load, in any direction the load may be applied.
    - d. Parapet or guardrails subject to direct loading by workers' ropes, possibly cables, shall be designed to withstand such loading (typically 1,800 lbs) without damage to either the structure of the rigging component in contact with it.

### **2.2 METALS**

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- C. Stainless-Steel Sheet, Strip, and Plate: ASTM A240/A240M or ASTM A666, Type 304.
- D. Stainless-Steel Bars and Shapes: ASTM A276, Type 304.
- E. Steel Tubing: ASTM A500/A500M, cold-formed steel tubing.
- F. Steel Pipe: ASTM A53/A53M, Standard Weight (Schedule 40) unless otherwise indicated.
- G. Slotted Channel Framing: Cold-formed metal box channels (struts) complying with MFMA-4.
  - 1. Size of Channels: 1-5/8 by 1-5/8 inches.
  - 2. Material: Cold-rolled steel, ASTM A1008/A1008M, structural steel, Grade 33; 0.0966-inch minimum thickness; unfinished.
- H. Aluminum Plate and Sheet: ASTM B209, Alloy 6061-T6.
- I. Aluminum Extrusions: ASTM B221, Alloy 6063-T6.
- J. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B632M, Alloy 6061-T6.
- K. Aluminum Castings: ASTM B26/B26M, Alloy 443.0-F.

## 2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
  - 1. Provide stainless-steel fasteners for fastening aluminum.
  - 2. Provide stainless-steel fasteners for fastening stainless steel.
  - 3. Provide stainless-steel fasteners for fastening nickel silver.
  - 4. Provide bronze fasteners for fastening bronze.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- C. High-Strength Bolts, Nuts, and Washers: ASTM F3125/F3125M, Grade A325, Type 3, heavy-hex steel structural bolts; ASTM A563, Grade DH3, heavy-hex carbon-steel nuts; and where indicated, flat washers.
- D. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F593; with hex nuts, ASTM F594; and, where indicated, flat washers; Alloy Group 1.
- E. Anchor Bolts: ASTM F1554, Grade 55, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
  - 1. Hot-dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.
- F. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
- G. Cast-in-Place Anchors in Concrete: Either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A47/A47M malleable iron or ASTM A27/A27M cast steel. Provide bolts, washers, and shims as needed, all hot-dip galvanized per ASTM F2329.
- H. Post-Installed Anchors: chemical anchors.
  - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
  - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.
- I. Slotted-Channel Inserts: Cold-formed, hot-dip galvanized-steel box channels (struts) complying with MFMA-4, 1-5/8 by 7/8 inches by length indicated with anchor straps or studs not less than 3 inches long at not more than 8 inches o.c. Provide with temporary filler and tee-head bolts, complete with washers and nuts, all zinc-plated to comply with ASTM B633, Class Fe/Zn 5, as needed for fastening to inserts.

## 2.4 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Division 09 Painting Sections.
- B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

- D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- E. Concrete: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 4000 psi.

## **2.5 FABRICATION, GENERAL**

- A. Galvanizing Locations:
  - 1. Any exterior steel, whether in contact with exterior air or concealed within an exterior wall is to be hot-dip galvanized unless noted as stainless steel.
  - 2. Any interior steel is to be primed and painted unless otherwise noted.
    - a. Metal grating, ladders, cages, railings, maintenance platform and other metal fabrications specified in this section that are located in interior mechanical spaces to be galvanized.
- B. Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.
- F. Weld corners and seams continuously to comply with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.
- H. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- I. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- J. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.
- K. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 by 1-1/2 inches, with a minimum 6-inch embedment and 2-inch hook, not less than 8 inches from ends and corners of units and 24 inches o.c., unless otherwise indicated.

## **2.6 MISCELLANEOUS FRAMING AND SUPPORTS**

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.
  - 1. Fabricate units from slotted channel framing where indicated.
  - 2. Furnish inserts for units installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports where indicated.
- D. Prime miscellaneous framing and supports with primers specified in Division 09 Section "Painting".

## **2.7 SHELF ANGLES**

- A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.
  - 1. Provide mitered and welded units at corners.
  - 2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.
- B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.
- C. Galvanize shelf angles located in exterior walls, unless noted otherwise on Drawings.
- D. Prime shelf angles located in exterior walls with primer specified in Division 09 Section "Painting."
- E. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

## **2.8 METAL LADDERS**

- A. General:
  - 1. Comply with ANSI A14.3.
  - 2. For elevator pit ladders, comply with ASME A17.1/CSA B44.
- B. Steel Ladders:
  - 1. Space siderails 18 inches apart unless otherwise indicated.
  - 2. Siderails: Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges.
  - 3. Rungs: 3/4-inch-diameter or 3/4-inch-square steel bars.
  - 4. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
  - 5. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
  - 6. Provide nonslip surfaces on top of each rung by coating with abrasive material metallicly bonded to rung.
  - 7. Provide platforms as indicated fabricated from welded steel bar grating, supported by steel angles. Limit openings in gratings to no more than 3/4 inch in least dimension.
  - 8. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted steel brackets.
  - 9. Galvanize ladders, including brackets.



## **2.9 LADDER SAFETY CAGES**

- A. General:
  - 1. Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or with stainless-steel fasteners.
  - 2. Provide primary hoops at tops and bottoms of cages and spaced not more than 20 feet o.c. Provide secondary intermediate hoops spaced not more than 48 inches o.c. between primary hoops.
  - 3. Fasten assembled safety cage to ladder rails and adjacent construction by welding or with stainless-steel fasteners unless otherwise indicated.
- B. Steel Ladder Safety Cages:
  - 1. Primary Hoops: 1/4-by-4-inch flat bar hoops.
  - 2. Secondary Intermediate Hoops: 1/4-by-2-inch flat bar hoops.
  - 3. Vertical Bars: 3/16-by-1-1/2-inch flat bars secured to each hoop.
  - 4. Galvanize ladder safety cages, including brackets and fasteners.

## **2.10 METAL SHIPS' LADDERS**

- A. Provide metal ships' ladders where indicated. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.
  - 1. Treads shall be not less than 5 inches exclusive of nosing or less than 8-1/2 inches including the nosing, and riser height shall be not more than 9-1/2 inches.
  - 2. Fabricate ships' ladders, including railings from steel.
  - 3. Fabricate treads and platforms from welded or pressure-locked steel bar grating. Limit openings in gratings to no more than 1/2 inch in least dimension.
  - 4. Comply with applicable railing requirements in Division 05 Section "Decorative Metal Stairs & Railings."
- B. Galvanize steel ships' ladders, including treads, railings, brackets, and fasteners.

## **2.11 MECHANICAL PLATFORM**

- A. Fabricate of open-type construction with channel or plate stringers and pipe and tube railings unless otherwise indicated. Provide brackets and fittings for installation.
  - 1. Fabricate treads and platforms from welded or pressure-locked steel bar grating. Limit openings in gratings to no more than 1/2 inch in least dimension.
  - 2. Comply with applicable railing requirements in Division 05 Section "Decorative Metal Stairs & Railings."
- B. Galvanize mechanical platform, including railings, brackets, and fasteners.

## **2.12 AREAWAY GRATINGS**

- A. Replace all existing metal gratings in the building and provide in new locations as indicated on the Drawings.
- B. Structural Performance: Gratings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
  - 1. Floors: Uniform load of 100 lbf/sq. ft. or concentrated load of 1000 lbf, whichever produces the greater stress.
  - 2. Walkways and Elevated Platforms Other Than Exits: Uniform load of 60 lbf/sq. ft..
  - 3. Limit deflection to L/360 or 1/4 inch, whichever is less.
- C. Basis-of-Design Manufacturer: Ohio Gratings, or approved equivalent.
  - 1. Electroforged Bar Grating, Welded construction:
    - a. See Structural Drawings for grate information.

- b. Traffic surface and Finish: Smooth surface; Powder Coated.
  - c. Traffic surface and finish for all other grates, including ship's ladder treads and maintenance platform: Knurled; Galvanized.
- D. Removable Grating Sections:
- 1. Reproduce existing areaway hatch size, location, hinging, latch and lock.
  - 2. Fabricate with banding bars attached by welding to entire perimeter of each section.
- E. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
- 1. Edge-band openings in grating that interrupt four or more bearing bars with bars of same size and material as bearing bars.

## **2.13 GRATING FRAMES AND SUPPORTS**

- A. Frames and Supports for Metal Grating at Areaway:
- 1. Keep all existing galvanized grating supports.
  - 2. Inspect all supports and tighten bolts.
  - 3. Inspect existing areaway ladder to remain. See Division 9 Section 'Painting' for touch up of galvanized frame and ladder.
- B. Frames and Supports for all other Metal Gratings: Fabricate from metal shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.
- 1. Unless otherwise indicated, fabricate from same basic metal as gratings.
  - 2. Equip units indicated to be cast into concrete or built into masonry with integrally welded anchors. Unless otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.
- C. Galvanize all steel frames and supports.

## **2.14 ROOF TIEOFF ANCHOR SYSTEM**

- A. Provide delegated design for the following:
- 1. Tie off anchors as shown on the Drawings
- B. Acceptable manufacturers and installers:
- 1. Summit Anchor Company or approved equivalent.
  - 2. Anchor eye size: Not less than 3/4 inch (20 mm) diameter material with 2 1/4 in (60 mm) eye opening.
  - 3. Anchor eye metals:
    - a. Forged, 1030 quenched and tempered per ASTM 576-90-b, 72ksi minimum
    - b. Stainless steel, type 304, solution annealed, 35 ksi minimum
  - 4. Flashing with one E.P.D.M. gasket seal top and base
    - a. Seamless Spun Aluminum Flashing: ASTM B221; Type 6061-T6 alloy
    - b. Stainless Steel: 304

## **2.15 ROOF SAFETY RAIL**

- A. Provide delegated design for the following:
- 1. Painted steel railing system with gates as shown on the Drawings.
- B. Basis of Design: Provide ballasted roof safety rail system as manufactured by KeeGuard Roof Railing appropriate for PVC roof installation, or approved equivalent.
- 1. Free Standing Non Counter Weight System.
  - 2. Tube Rails and Posts:

- a. ASTM A-55 Carbon Steel with Zinc Spelter, ASTM B-6 High Grade Special High Grade Zinc.
    - b. Guardrail top and intermediate rails and vertical support legs are produced in 1.9" external diameter steel (wall thickness 0.109").
  - 3. Bases:
    - a. Recycled PVC, produced in two halves.
  - 4. Cast Clamps:
    - a. Galvanized malleable cast iron produced to ASTM A47-77-32510.
    - b. Threadcoat applied to all tapped holes.
  - 5. Layout:
    - a. Guardrail height: 42".
    - b. Vertical supports set at 10' o.c. maximum.
- C. Railing design must provide adequate clearances around photovoltaic panel installation.
- 1. Roof safety rail manufacturer and installer must work with photovoltaic panel installer to assure coordination of rooftop elements.

## **2.16 LOADING DOCK STAIR RAILINGS**

- A. See Division 05 Section "Decorative Metal Stairs & Railings" for performance requirements for stair railings.
  - 1. See Drawings for configurations of railings at loading dock.
  - 2. Finish: Powder Coated; Color to match Architect's sample.

## **2.17 ELEVATOR PIT SUMP COVERS**

- A. Fabricate from welded or pressure-locked steel bar grating Limit openings in gratings to no more than 1/2 inch in least dimension.
- B. Provide steel angle supports as indicated.

## **2.18 MISCELLANEOUS STEEL TRIM**

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
  - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.
- C. Galvanize exterior miscellaneous steel trim.
- D. Prime exterior and interior miscellaneous steel trim with zinc-rich primer.

## **2.19 LOOSE BEARING AND LEVELING PLATES**

- A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.
- B. Galvanize plates.

## **2.20 LOOSE STEEL LINTELS**

- A. Fabricate loose steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated. Fabricate in single lengths for

each opening unless otherwise indicated. Weld adjoining members together to form a single unit where indicated.

- B. Size loose lintels to provide bearing length at each side of openings equal to 1/12 of clear span, but not less than 8 inches unless otherwise indicated.
- C. Galvanize loose steel lintels located in exterior walls.

## **2.21 STEEL WELD PLATES AND ANGLES**

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

## **2.22 FRAMING FOR INTERIOR ARCHITECTURAL WOODWORK**

- A. Shop fabricate and assemble framing for interior architectural woodwork to the maximum extent possible. Locate field joints at concealed locations, if possible. Detail assemblies to minimize handling and to expedite erection.
- B. Fabrication:
  - 1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale and roughness.
  - 2. Grind sheared, punched, and flame cut edges to remove burrs and provide smooth surfaces and edges.
  - 3. Fabricate with exposed surfaces free of mill marks, including rolled trade names and stamped or raised identification.
  - 4. Fabricate with exposed surfaces free of seams to maximum extent possible.
  - 5. Remove blemishes by filing or grinding or by welding and grinding, before cleaning, treating, and shop priming.
  - 6. Fabricate with piece marks fully hidden in the completed structure or made with media that permits full removal after erection.
  - 7. Seal weld open ends of hollow structural sections with 3/8 inch closure plates.
  - 8. Bolt holes: Cut, drill, or punch standard bolt holes perpendicular to metal surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
- C. Welding:
  - 1. Install filler material at stitch welded connections for a finished appearance of a continuous welded connection.

## **2.23 FINISHES, GENERAL**

- A. Finish metal fabrications after assembly.
- B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

## **2.24 STEEL AND IRON FINISHES**

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
  - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
- B. Preparation for Shop Priming Galvanized Items: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic phosphate process.

- C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
  - 1. Shop prime with primers specified in Division 09 Section "Painting."
- D. Preparation for Shop Priming: Prepare surfaces to comply with requirements indicated below:
  - 1. Exterior Items and Items to Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 2. Framing for Interior Architectural Woodwork: SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
  - 3. Other Items: SSPC-SP 3, "Power Tool Cleaning."
- E. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
  - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

## **2.25 ALUMINUM FINISHES**

- A. As-Fabricated Finish: AA-M12.

## **2.26 STAINLESS STEEL FINISHES**

- A. Remove tool and die marks and stretch lines or blend into finish.
- B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
- C. Dull Satin Finish: No. 6.
- D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION, GENERAL**

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws, and other connectors.

- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- F. Corrosion Protection: Coat concealed surfaces of aluminum that come into contact with grout, concrete, masonry, wood, or dissimilar metals with the following:
  - 1. Cast Aluminum: Heavy coat of bituminous paint.
  - 2. Extruded Aluminum: Two coats of clear lacquer.

### **3.2 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS**

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.
- B. Anchor supports for security grilles securely to, and rigidly brace from, building structure.
- C. Support steel girders on solid grouted masonry, concrete, or steel pipe columns. Secure girders with anchor bolts embedded in grouted masonry or concrete or with bolts through top plates of pipe columns.
  - 1. Where grout space under bearing plates is indicated for girders supported on concrete or masonry, install as specified in "Installing Bearing and Leveling Plates" Article.
- D. Install pipe columns on concrete footings with grouted baseplates. Position and grout column baseplates as specified in "Installing Bearing and Leveling Plates" Article.
  - 1. Grout baseplates of columns supporting steel girders after girders are installed and leveled.

### **3.3 INSTALLING BEARING AND LEVELING PLATES**

- A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of plates.
- B. Set bearing and leveling plates on wedges, shims, or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with nonshrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

### **3.4 ADJUSTING AND CLEANING**

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
  - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 Painting Sections.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A780/A780M.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum and steel.

2. Plastic Materials
3. Corrugated cardboard packaging.

C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 05 50 00**

## **SECTION 05 58 13 - COLUMN COVERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes snap-together metal column covers.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product, including finishing materials.
- B. Shop Drawings: Show fabrication and installation details for column covers.
- C. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes.
- D. Samples for Verification: For each type of exposed finish required, prepared on 6-inch-square Samples of metal of same thickness and material indicated for the Work.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For fabricator.
- B. Mill Certificates: Signed by stainless-steel manufacturers certifying that products furnished comply with requirements.

#### **1.5 QUALITY ASSURANCE**

- A. Fabricator Qualifications: A firm experienced in producing column covers similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
  - 1. Build mockups of column cover at column B'23'.
  - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver column covers wrapped in protective coverings and strapped together in suitable packs or in heavy-duty cartons. Remove protective coverings before they stain or bond to finished surfaces.

### **PART 2 - PRODUCTS**

#### **2.1 SNAP-TOGETHER COLUMN COVERS**

- A. Basis of Design: Provide column covers manufactured by Gordon, or approved equivalent.



- B. Form column covers to shapes indicated from metal of type and minimum thickness indicated below. Return vertical edges and bend to form hook that engages continuous mounting clips.
  - 1. Stainless-Steel Sheet: ASTM A240/A240M or ASTM A666, Type 304, 16 gage.
    - a. Finish: No. 6.
  - 2. Column covers may be fabricated from prefinished metal sheet in lieu of finishing after fabrication provided unfinished edges are concealed from view.
  - 3. Increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as needed to provide flat surfaces where indicated.
  - 4. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.
  - 5. Form returns at vertical joints to provide hairline V-joints.
  - 6. Fabricate column covers without horizontal joints.
  - 7. Provide base reveal as detailed in Drawings.
    - a. Fabricate base reveal ring to match column covers.
  - 8. Fabricate with calk stop/stiffener ring.
  - 9. Apply manufacturer's recommended sound-deadening insulation or mastic to backs of column covers.

## **2.2 MISCELLANEOUS MATERIALS**

- A. Fasteners: Fabricated from same basic metal and alloy as fastened metal unless otherwise indicated. Do not use metals that are incompatible with materials joined.
  - 1. Provide concealed fasteners for interconnecting column covers and for attaching them to other work unless otherwise indicated.
- B. Sound-Deadening Materials:
  - 1. Insulation: Unfaced, mineral-fiber blanket insulation complying with ASTM C665, Type I, and passing ASTM E136 test.
  - 2. Mastic: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- C. Backing Materials: Provided or recommended by column cover manufacturer.

## **2.3 FABRICATION, GENERAL**

- A. Coordinate dimensions and attachment methods of column covers with those of adjoining construction to produce integrated assemblies with closely fitting joints and with edges and surfaces aligned unless otherwise indicated.
- B. Form metal to profiles indicated, in maximum lengths to minimize joints. Produce flat, flush surfaces without cracking or grain separation at bends.

## **2.4 GENERAL FINISH REQUIREMENTS**

- A. Complete mechanical finishes of flat sheet metal surfaces before fabrication where possible. After fabrication, finish all joints, bends, abrasions, and other surface blemishes to match sheet finish.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## **2.5 STAINLESS-STEEL FINISHES**

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Dull Satin Finish: No. 6.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of column covers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Locate and place column covers plumb and in alignment with adjacent construction. Perform cutting, drilling, and fitting required to install column covers.
  - 1. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.
- B. Use concealed anchorages where possible.
- C. Form tight joints with exposed connections accurately fitted together. Provide reveals and openings for sealants and joint fillers as indicated.
- D. Corrosion Protection: Apply bituminous paint or other permanent separation materials on concealed surfaces where metals would otherwise be in direct contact with substrate materials that are incompatible or could result in corrosion or deterioration of either material or finish.

### **3.3 ADJUSTING AND CLEANING**

- A. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

### **3.4 PROTECTION**

- A. Protect finishes from damage during construction period. Remove temporary protective coverings at time of Substantial Completion.

**END OF SECTION 05 58 13**

## **SECTION 05 70 00 - DECORATIVE METAL**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Stainless steel and aluminum decorative extrusions, plates and other trim pieces.
  - 2. Powder coated steel supports and frames for casework specified in Division 06 Section "Interior Architectural Woodwork."
  - 3. Perforated aluminum plate for millwork specified in Division 06 Section "Interior Architectural Woodwork."
- B. Related Requirements:
  - 1. Division 05 Section "Decorative Metal Stairs & Railings" for decorative metal railings.

#### **1.3 COORDINATION**

- A. Coordinate installation of anchorages for decorative metal items. 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.

#### **1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product, including finishing materials.
- B. Shop Drawings: Show fabrication and installation details for decorative metal.
  - 1. Include plans, elevations, component details, and attachment details.
  - 2. Indicate materials and profiles of each decorative metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.
- C. Samples for Initial Selection: For products involving selection of color, texture, or design including mechanical finishes.
- D. Samples for Verification: For each type of exposed finish.
  - 1. Sections of linear shapes.
  - 2. Samples of welded joints showing quality of workmanship and color matching of materials.

#### **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For fabricator and finish applicator.
- B. Mill Certificates: Signed by manufacturers of stainless-steel certifying that products furnished comply with requirements.

- C. Welding certificates.

## **1.7 QUALITY ASSURANCE**

- A. Fabricator Qualifications: A firm experienced in producing decorative metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.
- B. Installer Qualifications: Fabricator of products.
- C. Organic-Coating Applicator Qualifications: A firm experienced in successfully applying organic coatings, of type indicated, to aluminum extrusions and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
- D. Powder-Coating Applicator Qualifications: A firm experienced in successfully applying powder coatings of type indicated and employing competent control personnel to conduct continuing, effective quality-control program to ensure compliance with requirements.
- E. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
  - 3. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
  - 4. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."
- F. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
  - 1. Build mockups for the following types of decorative metal:
    - a. Powder coated casework frame as shown in Drawings.
  - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## **1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Store decorative metal in a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

## **1.9 FIELD CONDITIONS**

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with decorative metal by field measurements before fabrication and indicate measurements on Shop Drawings.

## **PART 2 - PRODUCTS**

### **2.1 METALS, GENERAL**

- A. Metal Surfaces, General: Use materials with smooth, flat surfaces unless otherwise indicated. Use materials without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

### **2.2 ALUMINUM**

- A. Fabricate products from 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.
- B. Bars and Shapes: ASTM B221, Alloy 6063-T5/T52.

- C. Pipe and Round Tubing: ASTM B429/B429M, Alloy 6063-T6.
- D. Tubing: ASTM B210, Alloy 6063-T832.
- E. Plate and Sheet: ASTM B209, Alloy 5005-H32.
- F. Forgings: ASTM B247, Alloy 6061-T6.
- G. Castings: ASTM B26/B26M, Alloy A356.0-T6.
- H. Perforated Plate: ASTM B 209, Alloy 5005-H32.
  - a. 1/8" thickness
  - b. Typical basic perforation pattern: 1/2" diameter holes on 1" o. c. spacing, with holes in Round-Straight stacked grid pattern.
  - c. Provide different panel types with graduated perforation designs as illustrated in the Drawings.
  - d. Hold back perforation pattern from hemmed edges on three sides of panel, as shown in Drawings. Eliminate holes that would partially cut through at the bottom edge or bend at the hemmed edges.
  - e. Finish: Clear anodized.
  - f. Use: Custom millwork specified in Division 06 Section "Interior Architectural Woodwork."

### **2.3 STAINLESS STEEL**

- A. Tubing: ASTM A554, [Grade MT 304] [Grade MT 316] [Grade MT 316L].
- B. Pipe: ASTM A312/A312M, [Grade TP 304] [Grade TP 316] [Grade TP 316L].
- C. Castings: ASTM A743/A743M, [Grade CF 8 or Grade CF 20] [Grade CF 8M or Grade CF 3M].
- D. Sheet, Strip, Plate, and Flat Bar: ASTM A666, Type 304.
- E. Bars and Shapes: ASTM A276, Type 304.

### **2.4 STEEL AND IRON**

- A. Tubing: [ASTM A500/A500M (cold formed)] [or] [ASTM A513, Type 5 (mandrel drawn)].
- B. Bars: Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.
- C. Plates, Shapes, and Bars: ASTM A36/A36M.
- D. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.
- E. Steel Sheet, Cold Rolled: ASTM A1008/A1008M, either commercial steel or structural steel, exposed.

### **2.5 FASTENERS**

- A. Fastener Materials: Unless otherwise indicated, provide the following:
  - 1. Aluminum Items: Type 304 stainless-steel fasteners.
  - 2. Stainless-Steel Items: Type 304 stainless-steel fasteners.
  - 3. Dissimilar Metals: Type 304 stainless-steel fasteners.

- B. Fasteners for Anchoring to Other Construction: Unless otherwise indicated, select fasteners of type, grade, and class required to produce connections suitable for anchoring indicated items to other types of construction indicated.
- C. Provide concealed fasteners for interconnecting components and for attaching decorative metal items to other work unless otherwise indicated.
  - 1. Provide square drive countersunk machine screws for exposed fasteners unless otherwise indicated.
- D. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 or ICC-ES AC308.
  - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5 unless otherwise indicated.
  - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.

## **2.6 MISCELLANEOUS MATERIALS**

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
  - 1. For aluminum, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- B. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

## **2.7 FABRICATION, GENERAL**

- A. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- B. Make up wire-rope assemblies in the shop to field-measured dimensions with fittings machine swaged. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.
- C. Form decorative metal to required shapes and sizes, true to line and level with true curves and accurate angles and surfaces. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.
- E. Form simple and compound curves in bars, pipe, tubing, and extruded shapes by bending members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces.
- F. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- G. Mill joints to a tight, hairline fit. Cope or miter corner joints. Fabricate connections that will be exposed to weather in a manner to exclude water.
- H. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.

- I. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Cut, reinforce, drill, and tap as needed to receive finish hardware, screws, and similar items unless otherwise indicated.
- J. Comply with AWS for recommended practices in shop welding.
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Weld behind finished surfaces without distorting or discoloring exposed side.
  - 3. Obtain fusion without undercut or overlap.
  - 4. Remove welding flux immediately, and dress exposed and contact surfaces.
  - 5. Weld exposed corners and seams continuously unless otherwise indicated.
  - 6. At exposed connections, finish exposed welds to comply with NOMMA's 1994 "Voluntary Joint Finish Standards" for Finish #1 - No evidence of a welded joint.
  - 7. Where welding cannot be concealed behind finished surfaces, finish joints to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 1 Welds: no evidence of a welded joint.

## **2.8 FINISHES, GENERAL**

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

## **2.9 ALUMINUM FINISHES**

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. Clear Anodic Finish: AAMA 611, [AA-M12C22A41, Class I, 0.018 mm] [AA-M12C22A31, Class II, 0.010 mm] or thicker.
- A. Powder Coat Finish for Perforated Aluminum Sheet and Plates and all related brackets, trim, attachments, accessories and hardware: High Performance Powder Coat Finish, AAMA 2605.
  - 1. Colors: Custom colors to match architect's samples. Colors may include exotic colors or metallic finishes.
  - 2. Number of Colors Required: Three (3).
- B. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - 1. Color and Gloss: Match Architect's sample.

## **2.10 STAINLESS-STEEL FINISHES**

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
  - 1. Run grain of directional finishes with long dimension of each piece.
- C. Dull Satin Finish: No. 6.
- D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of decorative metal.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION, GENERAL**

- A. Provide anchorage devices and fasteners where needed to secure decorative metal to in-place construction.
- B. Perform cutting, drilling, and fitting required to install decorative metal. Set products accurately in location, alignment, and elevation, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.
- C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of decorative metal, restore finishes to eliminate evidence of such corrective work.
- D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.
- E. Install concealed gaskets, joint fillers, insulation, and flashings as work progresses.
- F. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.
  - 1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.
- G. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding and requirements for welding and for finishing welded connections in "Fabrication, General" Article. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
- H. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
  - 1. 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.
- I. Coordination with Millwork and Interior Glazing Assemblies: Coordinate installation of decorative metals supporting millwork and interior glazing assemblies to assure that completed assembly meets the overall dimensional tolerances. Adjust as required by related work.
- J. Fasteners: Install all fasteners in direction indicated on drawings, unless otherwise noted.

### **3.3 CLEANING AND PROTECTION**

- A. Unless otherwise indicated, clean metals by washing thoroughly with clean water and soap, rinsing with clean water, and drying with soft cloths.



- B. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
  - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- C. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 Section "Painting."
- D. Protect finishes of decorative metal from damage during construction period with temporary protective coverings approved by decorative metal fabricator. Remove protective covering at time of Substantial Completion.
- E. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

### **3.4 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
  - 1. Separate tempered glass waste for use as aggregate of nonstructural fill.
- C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum and stainless steel.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 05 70 00**

## **SECTION 05 71 00 - DECORATIVE METAL STAIRS & RAILINGS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes:
  - 1. Stair A & B: Stairs, Railings & Gates
  - 2. Balcony Cable Rail
  - 3. Lobby Glass Railing & Shoe
- B. Related Requirements:
  - 1. Division 04 Section "Stone Masonry" for bluestone treads and paving for stair landings.
  - 2. Division 08 Section "Glazing" for glass used in glass railings.
  - 3. Division 09 Section "Non-Structural Metal Framing" for metal backing for anchoring railings.
  - 4. Division 09 Section "Painting" for primers.

#### **1.3 COORDINATION AND SCHEDULING**

- A. Coordinate installation of anchorages for railings. 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 items to Project site in time for installation.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For metal stairs and the following:
  - 1. Shop primer products.
  - 2. Grout.
  - 3. Stair gate hold open.
  - 4. Stair gate hinges.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, details, and attachments to other work for:
    - a. Stairs
    - b. Balcony cable rail
    - c. Lobby glass railing
    - d. Any other railings or stairs indicated on the drawings to be included in this section.
  - 2. Indicate sizes of metal sections, thickness of metals, profiles, holes, and field joints.
  - 3. Include plan at each level.
  - 4. Provide templates for anchors and bolts specified for installation in other Sections.
  - 5. Show gates, hardware and hold open devices.
- C. Samples for Initial Selection: For products involving selection of color, texture, or design.
  - 1. 12" long section of stainless steel handrail.
  - 2. Sample of each part of stainless steel cable rail system.
  - 3. Glass railing shoe and other associated hardware.

## **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For professional engineer's experience with providing delegated-design engineering services of the kind indicated, including documentation that the engineer is licensed in the jurisdiction in which Project is located.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for stairs and railings.
  - 1. Test railings according ASTM E 894 and ASTM E 935.

## **1.6 QUALITY ASSURANCE**

- A. Installer Qualifications: Fabricator of products.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
  - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."
- C. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
  - 1. Freestanding Mockup for Stair A: to include stanchion, top rail, handrail, handrail bracket, and corner of infill panel. Mockup to be 18" square.
  - 2. Handrail welding mockup: provide sample of welded corner of stainless steel handrail, 8" square or larger.
  - 3. Build in place mockups for each form and finish of railing consisting of two posts, top rail, handrail, brackets, infill area, and anchorage system components that are full height and are not less than 24 inches in length. Mockups shall be prepared for each type of railing in the Project.
    - a. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## **1.7 COORDINATION**

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for metal stairs. 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.
- C. 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.

## **1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Store materials to permit easy access for inspection and identification.
  - 1. Keep members off ground and spaced by using pallets, dunnage, or other supports and spacers.
  - 2. Protect members and packaged materials from corrosion and deterioration.

3. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.
  - a. Repair or replace damaged materials or structures as directed.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design stairs, and railings, including attachment to building construction.
- B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
  1. Stainless Steel: 60 percent of minimum yield strength.
  2. Steel: 72 percent of minimum yield strength.
  3. Glass: 25 percent of mean modulus of rupture (50 percent probability of breakage), as listed in "Mechanical Properties" in AAMA's Aluminum Curtain Wall Series No. 12, "Structural Properties of Glass."
- C. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
  1. Uniform Load: 100 lbf/sq. ft.
  2. Concentrated Load: 300 lbf applied on an area of 4 sq. in..
  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/720 or 1/8 inch, whichever is less.
- D. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated.
  1. Handrail assemblies and guards:
    - a. Uniform load of 50 lbf/ft. applied in any direction, and to transfer that load through the supports to the structure.
    - b. Concentrated load of 200 lbf applied in any direction along the top, and to have attachment devices and supporting structure to transfer this loading to appropriate structural elements of the building.
    - c. Uniform and concentrated loads need not be assumed to act concurrently.
  2. Components: Intermediate rails (all except the handrail), balusters and panel fillers:
    - a. Concentrated load of 200 lbf applied horizontally on an area of 1 sq. ft., including openings and space between rails.
    - b. Uniform load of 25 lbf/sq. ft. applied horizontally.
    - c. Intermediate rail, balusters and panel filler loads, need not be assumed to act concurrently with loads specified for handrail assemblies and guards.
- E. Seismic Performance: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

### **2.2 METALS**

- A. Metal Surfaces: Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.
- B. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

- C. Steel Tubing: [ASTM A500/A500M (cold formed)] [or] [ASTM A513/A513M].
- D. Stainless Steel Bars and Shapes: ASTM A276/A276M, Type 304.
- E. Uncoated, Cold-Rolled Steel Sheet: ASTM A1008/A1008M, structural steel, Grade 25, unless another grade is required by design loads; exposed.
- F. Uncoated, Hot-Rolled Steel Sheet: ASTM A1011/A1011M, structural steel, Grade 30, unless another grade is required by design loads.
- G. Galvanized-Steel Sheet: ASTM A653/A653M, G90 coating, structural steel, Grade 33, unless another grade is required by design loads.

## 2.3 FASTENERS

- A. General: Provide zinc-plated fasteners with coating complying with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls.
  - 1. Select fasteners for type, grade, and class required.
- B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.
- C. Anchor Bolts: ASTM F1554, Grade 36, of dimensions indicated; with nuts, ASTM A563; and, where indicated, flat washers.
  - 1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for stairs indicated to be galvanized.
- D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.
  - 1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/F1941M, Class Fe/Zn 5, unless otherwise indicated.
  - 2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.
- E. All exposed fasteners to be countersunk stainless steel square drive screws. See Drawings.

## 2.4 CABLE RAILINGS

- A. Cable Rail, Wire Rope and Fittings:
  - 1. General: Connectors of types indicated, fabricated from stainless steel, and with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.
  - 2. Basis of Design Manufacturer: Provide stainless steel fitting parts indicated as manufactured by C. Sherman Johnson Co, Inc, Johnson Architectural Hardware, or an approved equivalent:
    - a. Cables: ¼ inch or as indicated.
    - b. Button End Terminal: "Button Terminal" in sizes as required by wire size.
    - c. Cable Rail Adjustor: "Classic Button Turnbuckle"
      - 1) Provide required number of turnbuckles on each run of railing, as determined by manufacturer.

## 2.5 GLASS RAILING & SHOE

- A. Glass-Supported Guardrail System:

1. Basis-of-Design: "RG500 Series" aluminum base shoe by CRL-Blumcraft, or approved equivalent.
  - a. Two-piece base shoe
  - b. Accepts  $\frac{3}{4}$ " glass, Type GL 6. See Division 08 Section "Glazing" for glazing description.
  - c. Provide RG50CBS10 Brushed Stainless Steel Cladding; Cladding is full coverage of the exposed portion of the base shoe – see Drawings.
  - d. Provide RG5ECBS Brushed Stainless Steel End Caps on all exposed ends of shoe.
  
- B. Glass Top Rail:
  1. Basis-of-Design: "GRUCBS10" Crisp Corner Low Profile Cap Rail by C.R. Laurence Co., Inc., or approved equivalent.
    - a. 11 gauge stainless steel, grade 304.
    - b. Size: 1-1/8" wide x 1-1/2" high channel, cut down to  $\frac{3}{4}$ " high. (Or provide s.s. channel shape from other source of required size.)
    - c. Finish: Brushed Stainless.
    - d. Provide vinyl insert required to secure glass, and end caps designed for this system.

## 2.6 GLASS AND GLAZING MATERIALS

- A. See Division 08 Section "Glazing" for glass types to be installed with work of this section.

## 2.7 GATES

- A. Gates: Provide railing gates within fire stairs at level of egress as shown on Drawings.
  1. Provide two (2) stainless steel spring hinges per gate leaf with 95 degree swing. Hinges to be rated for weight load produced by metal gate.
  
- B. Gate Hold Open Devices: BHMA A156.15; Grade 1; closer connected with separate or integral releasing and fire- or smoke-detecting devices. Gates shall become self-closing on interruption of signal to release device.
  1. Gates in fire stairs A and B to receive hold open devices.
  2. Basis of Design: Dorma EM 500 G, or approved equivalent that matches functional and precise dimensional requirements.
    - a. Holding force 400 N 24v AC/DC.
    - b. Provide 'MAT' armature plate fastened to gate in Stair A.
    - c. Provide 'MAG' armature plate fastened to gate in Stair B.
    - d. Provide separate manual release plate switch by same manufacturer.

## 2.8 MISCELLANEOUS MATERIALS

- A. Welding Electrodes: Comply with AWS requirements.
  
- B. Shop Primers: Provide primers that comply with Division 09 Painting Sections.
  1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
  
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
  
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
  
- E. Nonmetallic, Shrinkage-Resistant Grout: ASTM C1107/C1107M, factory-packaged, nonmetallic aggregate grout; recommended by manufacturer for interior use; noncorrosive and nonstaining; mixed with water to consistency suitable for application and a 30-minute working time.

## **2.9 FABRICATION, GENERAL**

- A. Provide complete stair assemblies, including metal framing, hangers, struts, 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.
  - 2. Use connections that maintain structural value of joined pieces.
- B. Assemble stairs in shop to greatest extent possible.
  - 1. Disassemble units only as necessary for shipping and handling limitations.
  - 2. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately.
  - 1. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated.
  - 2. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.
- F. Weld connections to comply with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Weld exposed corners and seams continuously unless otherwise indicated.
  - 5. At exposed connections, finish exposed welds to comply with NOMMA's 1994 "Voluntary Joint Finish Standards" for Finish #1 - No evidence of a welded joint.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible.
  - 1. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated.
  - 2. Locate joints where least conspicuous.

## **2.10 FABRICATION OF STAIRS**

- A. NAAMM Stair Standard: Comply with NAAMM AMP 510, "Metal Stairs Manual," for Architectural Class, unless more stringent requirements are indicated.
- B. Stair Framing:
  - 1. Fabricate stringers of steel channels as indicated on Drawings.
    - a. Stringer Depth: As indicated on Drawings.
    - b. Provide closures for exposed ends of channel stringers.
    - c. Finish: Shop primed.
  - 2. Construct platforms of steel headers and miscellaneous framing members as indicated on Drawings.
    - a. Provide closures for exposed ends of channel framing.
    - b. Finish: Shop primed.
  - 3. Weld stringers to headers; weld framing members to stringers and headers.
- C. Subtreads, Risers, and Subplatforms:
  - 1. Fabricate subtreads and subplatforms of steel plates as indicated on Drawings.
  - 2. Weld subtreads to stringers.
    - a. Locate welds on top of subtreads where they will be concealed by finished treads.

3. Provide subplatforms of configuration indicated or, if not indicated, the same as subreads.
  - a. Weld subplatforms to platform framing.
  - b. Locate welds on top of subplatforms where they will be concealed by finished flooring.
  - c. Smooth Soffit Construction: Construct subplatforms with flat metal under surfaces to produce smooth soffits.

## 2.11 STAIR RAILINGS

- A. Steel Railings: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, size of steel members, post spacings, and anchorage, but not less than that needed to withstand indicated loads.
  1. Rails and Posts: as indicated in the Drawings. For stairs in mechanical rooms and other non-public places which are not detailed in Drawings, provide 1-1/4-inch diameter round hand rail and 1-1/2" square top and mid rails and posts. Do not allow greater than a 21" diameter sphere to pass through railing at any point.
- B. Perforated Infill Panels:
  1. 1/8" minimum thickness stainless steel, or thickness needed to meet performance requirements.
  2. Typical basic perforation pattern: 1/2" diameter holes on 1" o. c. spacing, with holes in Round-Straight stacked grid pattern.
  3. Provide five (5) different panel types with graduated perforation designs as illustrated in the Drawings.
  4. Hold back perforation pattern from hemmed edges on three sides of panel, as shown in Drawings. Eliminate holes that would partially cut through at the bottom edge or bend at the hemmed edges.
- C. Welded Connections: Fabricate railings with 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.
  1. Finish welds at mechanical room stairs which are not in public areas, to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 3 welds: partially dressed weld with spatter removed.
  2. Finish welds at Stairs A & B guard rail and stainless-steel cable rail guard rail exterior of Café/Study 301 to be Type 1 welds: no evidence of a welded joint.
  3. Finish welds at all other stairs, to comply with NOMMA's "Voluntary Joint Finish Standards" for Type 2 welds: completely sanded joint, some undercutting and pinholes okay.
- D. Form changes in direction of railings as follows:
  1. By radius bends of radius indicated or by inserting prefabricated elbow fittings of radius indicated.
- E. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- F. Close exposed ends of railing members with prefabricated end fittings.
- G. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- H. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.



1. Connect posts to stair framing by direct welding unless otherwise indicated.
  2. For galvanized railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
  3. For nongalvanized railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.
- I. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

## **2.12 GLAZING PANEL FABRICATION**

- A. General: Fabricate to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.
1. Clean-cut or flat-grind edges at butt-glazed joints, whether they are designated to be finished with or without sealant, to produce square edges with slight chamfers at junctions of edges and faces
  2. Grind smooth exposed edges, including those at open joints, to produce square edges with slight chamfers at junctions of edges and faces.
- B. Structural Glass Balusters: Field glaze glass panels into aluminum shoe molding following manufacturer's instructions.
- C. Infill Panels: See Division 08 Section "Glazing."
- D. Include accessory items indicated or as required to complete work of this section.

## **2.13 FINISHES**

- A. Finish metal stairs after assembly.
- B. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- C. Steel Galvanized Finish: Hot-dip galvanize items as indicated to comply with ASTM A153/A153M for steel and iron hardware and with ASTM A123/A123M for other steel and iron products.
1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
  2. Fill vent and drain holes that are exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- D. Steel Shop Prime Finish:
1. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."
  2. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting.
    - a. Stripe paint corners, crevices, bolts, welds, and sharp edges.
- E. Stainless Steel Finishes:
1. Stainless Steel Tubing Finishes:
    - a. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.
    - b. Dull Satin Finish: No. 6 for perf plate infill.

- c. Brushed Finish No. 4 for s.s. tubes; direction is always length of material for any brushed finish.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verify elevations of floors, bearing surfaces and locations of bearing plates, and other embedments for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLING METAL STAIRS**

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction.
  - 1. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.
- B. Cutting, Fitting, and Placement: 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.
- C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
  - 1. Grouted Baseplates: Clean concrete- and masonry-bearing surfaces of bond-reducing materials and roughen surfaces prior to setting plates.
    - a. Clean bottom surface of plates.
    - b. Set plates for structural members on wedges, shims, or setting nuts.
    - c. Tighten anchor bolts after supported members have been positioned and plumbed.
    - d. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
    - e. Promptly pack grout solidly between bearing surfaces and plates so no voids remain.
      - 1) Neatly finish exposed surfaces; protect grout and allow to cure.
      - 2) Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.
- E. Fit exposed connections accurately together to form hairline joints.
  - 1. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations.
  - 2. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
  - 3. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.

### **3.3 INSTALLING RAILINGS**

- A. INSTALLATION, GENERAL
  - 1. Fit exposed connections together to form tight, hairline joints.
  - 2. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
    - a. Do not weld, cut, or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.

- b. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
  - c. 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.
3. Corrosion Protection: Coat concealed surfaces of aluminum and that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
  4. Adjust railings before anchoring to ensure matching alignment at abutting joints.
  5. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

**B. RAILING CONNECTIONS**

1. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
2. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.
3. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

**C. ANCHORING POSTS**

1. Leave anchorage joint exposed with anchoring material flush with adjacent surface.
2. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows, unless otherwise indicated on the Contract Documents:
  - a. For aluminum railings, attach posts as indicated using fittings designed and engineered for this purpose.
  - b. For stainless-steel railings, weld flanges to posts and bolt to metal-supporting surfaces.
  - c. For steel railings, weld flanges to posts and bolt to metal-supporting surfaces.

**D. ATTACHING RAILINGS**

1. Anchor railing ends to concrete and masonry with sleeves concealed within railing ends and anchored to wall construction with anchors and bolts, unless otherwise indicated on the Contract Documents.
2. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends or connected to railing ends using nonwelded connections, unless otherwise indicated on the Contract Documents.
3. Attach handrails to walls with wall brackets except where otherwise indicated. Provide brackets with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
  - a. Engineer brackets to comply with design drawings and with performance requirements for railings.
  - b. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt unless otherwise indicated.
  - c. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
4. Secure wall brackets and railing end flanges to building construction as follows:
  - a. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
  - b. For hollow masonry anchorage, use toggle bolts.

- c. For steel-framed partitions, fasten brackets directly to steel framing or concealed steel reinforcements using self-tapping screws of size and type required to support structural

### **3.4 INSTALLING GLASS PANELS**

- A. Glass-Supported Railings: Install assembly to comply with railing manufacturer's written instructions.
  - 1. Attach base channel to building structure, then insert glass into base channel and bond with glazing cement.
    - a. Support glass panels in base channel at quarter points with channel-shaped setting blocks that also act as shims to maintain uniform space for glazing cement. Fill remaining space in base channel with glazing cement for uniform support of glass.
  - 2. Adjust spacing of glass panels so gaps between panels are equal before securing in position.
  - 3. Erect glass railings under direct supervision of manufacturer's authorized technical personnel.

### **3.5 CLEANING**

- A. Clean aluminum and stainless steel by washing thoroughly with clean water and soap, rinsing with clean water, and wiping dry.
- B. Clean and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.
- C. Touchup Painting: 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 to comply with SSPC-PA 1 for touching up shop-painted surfaces.
  - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

### **3.6 PROTECTION**

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

### **3.7 REPAIRS**

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
  - 1. Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Division 09 Painting Sections.
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780/A780M.

### **3.8 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling.

**END OF SECTION 05 71 00**

## **SECTION 05 74 00 - GLAZED INTERIOR LIGHTWELL**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Point-supported glass skirts at top and bottom of light well.
  - 2. Frameless glass storefront with top and bottom shoes.
- B. Related Requirements:
  - 1. Division 05 Structural Steel for support framing for lightwell.
  - 2. Division 05 Section "Decorative Metal" for metal trim.
  - 3. Division 08 Section "Glazing" for glass used in lightwell.

#### **1.3 COORDINATION AND SCHEDULING**

- A. Coordinate installation of anchorages for glass skirts and storefront. 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 items to Project site in time for installation.

#### **1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For the following:
  - 1. Glass attachment fittings.
- B. Shop Drawings: Include plans, elevations, sections, and attachment details.
- C. Samples for Initial Selection: For products involving selection of color, texture, or design, including mechanical finishes.
- D. Samples for Verification: For each type of exposed finish required.
  - 1. Point-support glass button fittings.
  - 2. Glass storefront channel shoes.
  - 3. Each type of glass required.
- E. Delegated-Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For professional engineer.

- B. Mill Certificates: Signed by manufacturers of stainless steel products certifying that products furnished comply with requirements.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E894 and ASTM E935.
- D. Preconstruction test reports.
- E. Evaluation Reports: For post-installed anchors, from ICC-ES.

## **1.7 QUALITY ASSURANCE**

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
  - 1. Build mockups for frameless glass storefront, including sealant application, and point-supported glass skirts.
  - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## **1.8 FIELD CONDITIONS**

- A. Field Measurements: Verify actual locations of walls and other contiguous construction by field measurements before fabrication and indicate measurements on Shop Drawings.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Product Options: Information on Drawings and in Specifications establishes requirements for system's aesthetic effects and performance characteristics. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods, including structural analysis, preconstruction testing, field testing, and in-service performance.
  - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.

### **2.2 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Sections to design:
  - 1. Point-supported glass skirts, including attachment to building construction.
  - 2. Frameless glass storefront, including attachment to building construction.
- B. General: In engineering glass enclosures to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
  - 1. Aluminum: The lesser of minimum yield strength divided by 1.65 or minimum ultimate tensile strength divided by 1.95.
  - 2. Stainless Steel: 60 percent of minimum yield strength.
  - 3. Steel: 72 percent of minimum yield strength.
  - 4. Glass: 25 percent of mean modulus of rupture (50 percent probability of breakage), as listed in "Mechanical Properties" in AAMA's Aluminum Curtain Wall Series No. 12, "Structural Properties of Glass."
- C. Structural Performance: Glass storefront and skirts, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform load of 50 lbf/ft. applied in any direction.
  2. Concentrated load of 200 lbf applied in any direction.
  3. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
  4. Uniform and concentrated loads need not be assumed to act concurrently.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior railings by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- E. Accommodate deflection of floors and roof construction in stair design.

### **2.3 METALS, GENERAL**

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.

### **2.4 ALUMINUM**

- A. Aluminum, General: 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.
- B. Extruded Shoe Molding for glass railing installation: ASTM B 221, Alloy 6063-T5/T52.

### **2.5 STAINLESS STEEL**

- A. Tubing: ASTM A554, Grade MT 304.
- B. Pipe: ASTM A312/A312M, Grade TP 304.
- C. Sheet, Strip, Plate, and Flat Bar: ASTM A666 or ASTM A240/A240M, Type 304.
- D. Bars and Shapes: ASTM A276, Type 304.

### **2.6 STEEL AND IRON**

- A. Tubing: ASTM A500/A500M (cold formed) or ASTM A513.
- B. Bars: Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.
- C. Plates, Shapes, and Bars: ASTM A 36/A 36M.

### **2.7 GLASS AND GLAZING MATERIALS**

- A. See Division 08 Section "Glazing" for glass types to be installed with work of this section.

### **2.8 POINT-SUPPORT BUTTONS**

- A. Basis of Design: Subject to compliance with requirements, provide Glass Rail Standoff Base and Cap as manufactured by C. R. Laurence Co., Inc., or approved equivalent.
1. Catalog Number RSOB2134BS
  2. Size: 1 3/4" base with 2" diameter standoff fitting.
  3. Material: Alloy 316 stainless steel.



4. Mounting stud includes necessary rubber washers and grommet.
5. Finish: Brushed Stainless.
6. Buttons are to be mounted directly to the structural steel HSS tube frame, or via steel shims as required. See Drawings.

## **2.9 FRAMELESS GLASS STOREFRONT SHOES**

- A. Basis of Design: Subject to compliance with requirements, provide Avanti Systems, Inc., Greenwich, CT, or approved equivalent.
- B. Atrium Wall System, or approved equivalent.
  1. Material: Aluminum Extrusion; ASTM B221, 6063-T6 alloy and temper.
  2. Standard Track Single Glazed Base
    - a. 1" x 1" Two Piece Single Glazed Channel
  3. Standard Track Single Glazed Head
    - a. 1" x 2" One Piece Single Glazed Channel
  4. Finish: Stainless steel cladding with No. 4 directional satin finish.

## **2.10 BUTT-GLAZING SEALANT**

- A. Single-Component, Nonsag, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Uses NT, G and A.
  1. Ultra Clear or Crystal Clear sealant.
  2. Confirm compatibility between sealant and laminated glass interlayer.

## **2.11 FASTENERS**

- A. Fastener Materials: Unless otherwise indicated, provide the following:
  1. Aluminum Components: Type 304 stainless steel fasteners.
  2. Stainless Steel Components: Type 304 stainless steel fasteners.
  3. Uncoated Steel Components: Plated-steel fasteners complying with ASTM B 633, Class Fe/Zn 25 for electrodeposited zinc coating where concealed; Type 304 stainless-steel fasteners where exposed.
  4. Dissimilar Metals: Type 304 stainless steel fasteners.
- B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.
- C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless otherwise indicated.
  1. Provide countersunk square drive flat-head machine screws for exposed fasteners unless otherwise indicated.
- D. Anchors, General: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
- E. Post-Installed Anchors: Chemical anchors.
  1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
  2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

## **2.12 MISCELLANEOUS MATERIALS**

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
  - 1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- B. Shop Primers: Provide primers that comply with Division 09 painting Sections.
- C. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- D. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- E. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.

## **2.13 GLAZING PANEL FABRICATION**

- A. General: Fabricate to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.
  - 1. Clean-cut or flat-grind edges at butt-glazed sealant joints to produce square edges with slight chamfers at junctions of edges and faces.
  - 2. Grind smooth exposed edges, including those at open joints, to produce square edges with slight chamfers at junctions of edges and faces.
- B. Glaze glass panels into aluminum shoe molding following manufacturer's instructions.
- C. Include accessory items indicated or as required to complete work of this section.

## **2.14 GENERAL FINISH REQUIREMENTS**

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## **2.15 STAINLESS STEEL FINISHES**

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Dull Satin Finish: No. 6.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION, GENERAL**

- A. Fit exposed connections together to form tight, hairline joints.
- B. Perform cutting, drilling, and fitting required for installing storefront and skirts. Set shoes and buttons accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

- C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
  - 1. 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.
- D. Adjust fittings before anchoring to ensure matching alignment at abutting joints.
- E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing storefront and skirts and for properly transferring loads to in-place construction.

### **3.2 INSTALLING GLASS PANELS**

- A. Frameless Glass Storefront: Install assembly to comply with railing manufacturer's written instructions.
  - 1. Attach base channel to building structure, then insert and connect factory-fabricated and -assembled glass panels if glass was bonded to base and top-rail channels in factory.
  - 2. Attach base channel to building structure, then insert glass into base channel and bond with glazing cement unless glass was bonded to base and top-rail channels in factory.
    - a. Support glass panels in base channel at quarter points with channel-shaped setting blocks that also act as shims to maintain uniform space for glazing cement. Fill remaining space in base channel with glazing cement for uniform support of glass.
  - 3. Adjust spacing of glass panels so gaps between panels are equal before securing in position.
  - 4. Erect glass under direct supervision of manufacturer's authorized technical personnel.

### **3.3 INSTALLING SEALANT**

- A. Install clear sealant between glass panels to provide a smooth, even surface. No air pockets or waves will be accepted.
- B. Tool back from face of glass a consistent depth on both sides.

### **3.4 CLEANING**

- A. Clean aluminum and stainless steel by washing thoroughly with water and soap, rinsing with clean water, and wiping dry.
- B. Clean and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.

### **3.5 PROTECTION**

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

### **3.6 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

- B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
  - 1. Separate tempered glass waste for use as aggregate of nonstructural fill.
  
- C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum and stainless steel.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
  
- D. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 05 74 00**

## **SECTION 06 10 00 - ROUGH CARPENTRY**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  1. Rooftop equipment bases and support curbs.
  2. Wood blocking, cants, and nailers.
  3. Wood furring and grounds.
  4. Wood sleepers.
  5. Plywood backing panels.
  6. Engineered wood lumber.
  7. Fire retardant materials as required by the building code.
- B. Related Requirements:
  1. Division 6 Section "Sheathing" for sheathing and underlayment, and for fire retardant plywood used as blocking and sheathing when concealed within the construction.

#### **1.3 DEFINITIONS**

- A. Boards or Strips: Lumber of less than 2 inches nominal size in least dimension.
- B. Dimension Lumber: Lumber of 2 inches nominal size or greater but less than 5 inches nominal size in least dimension.
- C. OSB: Oriented strand board.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
  1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.
  2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
  3. For fire-retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5664.
  4. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
- B. Fastener Patterns: Full-size templates for fasteners in exposed framing.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Material Certificates: For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

- B. Evaluation Reports: For the following, from ICC-ES:
  - 1. Wood-preservative-treated wood.
  - 2. Fire-retardant-treated wood.
  - 3. Power-driven fasteners.
  - 4. Post-installed anchors.

## **1.6 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: For testing agency providing classification marking for fire-retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

## **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

## **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, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber 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.
- B. Maximum Moisture Content of Lumber: 19 percent unless otherwise indicated.
- C. Engineered Wood Products: Acceptable to authorities having jurisdiction and for which current model code research or evaluation reports exist that show compliance with building code in effect for Project.
  - 1. Allowable design stresses, as published by manufacturer, shall meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.

### **2.2 WOOD-PRESERVATIVE-TREATED LUMBER**

- A. Preservative Treatment by Pressure Process: AWPA U1; Use Category UC2[ for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground].
  - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
  - 2. For exposed items indicated to receive a stained or natural finish, chemical formulations shall not require incising, contain colorants, bleed through, or otherwise adversely affect finishes.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or that 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 items indicated on Drawings, and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
2. Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
3. Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
4. Wood framing members that are less than 18 inches above the ground in crawlspaces or unexcavated areas.
5. Wood floor plates that are installed over concrete slabs-on-grade.
6. Any wood installed on the exterior side of the weather envelope of the building.

## **2.3 FIRE-RETARDANT-TREATED MATERIALS**

- A. General: Where fire-retardant-treated materials are required by the building code, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
  
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
  1. Treatment shall not promote corrosion of metal fasteners.
  2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
    - a. Application: Treat items indicated on Drawings, and the following when rated construction is required, unless otherwise indicated:
      - 1) Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
      - 2) Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.
      - 3) Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
      - 4) Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
      - 5) Wood floor plates that are installed over concrete slabs-on-grade.
      - 6) Other locations where preservative treated wood is required and not specifically indicated as “preservative but not fire retardant treated.
  3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201 at 92 percent relative humidity. Use where exterior type is not indicated or required.
  4. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D5664 and design value adjustment factors shall be calculated according to ASTM D6841.
  
- C. Kiln-dry lumber after treatment to maximum moisture content of 19 percent.
  
- D. Identify fire-retardant-treated wood with appropriate classification marking of qualified testing agency.
  
- E. Application: Treat items indicated on Drawings, and the following:
  1. Concealed blocking, except for handrails, millwork, cabinets, and windows and door frames.
  2. Roof construction, including parapets, curbs, and railings.

3. 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.
  3. Rooftop equipment bases and support curbs.
  4. Cants.
  5. Furring.
  6. Grounds.
- B. Dimension Lumber Items: Construction or No. 2 grade lumber of any species.
- C. Concealed Boards: 19 percent maximum moisture content and any of the following species and grades:
  1. Mixed southern pine or southern pine; No. 2 grade; SPIB.
  2. Hem-fir or hem-fir (north); Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
  3. Spruce-pine-fir (south) or spruce-pine-fir; Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
  4. Eastern softwoods; No. 2 Common grade; NeLMA.
  5. Northern species; No. 2 Common grade; NLGA.
  6. Western woods; Construction or No. 2 Common grade; WCLIB or WWPA.
- D. For blocking not used for attachment of other construction, Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- E. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
- F. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

## **2.5 ENGINEERED WOOD PRODUCTS**

- A. Laminated-Veneer Lumber: Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D5456 and manufactured with an exterior-type adhesive complying with ASTM D2559.

## **2.6 PLYWOOD BACKING PANELS**

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch nominal thickness.

## **2.7 FASTENERS**

- A. General: Fasteners shall be of size and type indicated and shall comply with requirements specified in this article for material and manufacture.
  1. Where rough 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 A153/A153M.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: NES NER-272.



- D. Wood Screws: ASME B18.6.1.
- E. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
- F. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
- G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry assemblies and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.
  - 1. Material: Carbon-steel components, zinc plated to comply with ASTM B 633, Class Fe/Zn 5.
  - 2. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

## 2.8 MISCELLANEOUS MATERIALS

- A. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber or rubberized-asphalt compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- B. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.
- C. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
  - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.
- D. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
  - 1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
  - 2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal thickness.
  - 3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. and to solidly fill space below partitions.
  - 4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet o.c.
- E. Sort and select lumber so that natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function

of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

- F. Comply with AWPA M4 for applying field treatment to cut surfaces of preservative-treated lumber.
  - 1. Use inorganic boron for items that are continuously protected from liquid water.
  - 2. Use copper naphthenate for items not continuously protected from liquid water.
- G. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- H. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
  - 1. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code (IBC).
  - 2. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
  - 3. ICC-ES evaluation report for fastener.
- I. Use steel common nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.
- J. For exposed work, arrange fasteners in straight rows parallel with edges of members, with fasteners evenly spaced, and with adjacent rows staggered.
  - 1. Comply with approved or indicated fastener patterns where applicable. Before fastening, mark fastener locations, using a template made of sheet metal, plastic, or cardboard.
  - 2. Use finishing nails unless otherwise indicated. Countersink nail heads and fill holes with wood filler.
  - 3. Use common nails unless otherwise indicated. Drive nails snug but do not countersink nail heads.

### **3.2 WOOD BLOCKING, AND NAILER INSTALLATION**

- A. Install where indicated and where required for screeding or attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.
- A. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.

### **3.3 WOOD FURRING INSTALLATION**

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal-size furring horizontally at 24 inches o.c.
- C. Furring to Receive Gypsum Board: Install 1-by-2-inch nominal-size furring vertically at 16 inches o.c.

### **3.4 PROTECTION**

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 06 10 00**

## **SECTION 06 16 00 - SHEATHING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Wall sheathing.
  - 2. Fire retardant plywood used as blocking and interior sheathing when concealed within the construction.
  - 3. Sheathing joint and penetration treatment.
- B. Related Requirements:
  - 1. Division 06 Section "Rough Carpentry" for plywood backing panels.
  - 2. Division 07 Section "Fluid-Applied Membrane Air Barriers" for barrier applied over wall sheathing.
  - 3. Division 07 Section "PVC Roofing" for sheathing installed with membrane roofing.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
  - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
  - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
  - 3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D5516.
  - 4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Evaluation Reports: For the following, from ICC-ES:
  - 1. Wood-preservative-treated plywood.
  - 2. Fire-retardant-treated plywood.
- B. Field quality-control reports.

#### **1.5 QUALITY ASSURANCE**

- A. Testing Agency Qualifications:
  - 1. For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Fire-Resistance Ratings: As tested according to ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

### **2.2 WOOD PANEL PRODUCTS**

- A. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
- B. Factory mark panels to indicate compliance with applicable standard.

### **2.3 PRESERVATIVE-TREATED PLYWOOD**

- A. Preservative Treatment by Pressure Process: AWWA U1; Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
  - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
- C. Application: Treat items indicated on Drawings and/or plywood in contact with masonry or concrete or used with roofing, flashing, vapor barriers, and waterproofing.

### **2.4 FIRE-RETARDANT-TREATED PLYWOOD**

- A. General: Where fire-retardant-treated materials are required by the building code, use materials complying with requirements in this article that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
- B. Fire-Retardant-Treated Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet beyond the centerline of the burners at any time during the test.
  - 1. Use treatment that does not promote corrosion of metal fasteners.
  - 2. Exterior Type: Treated materials shall comply with requirements specified above for fire-retardant-treated plywood by pressure process after being subjected to accelerated weathering according to ASTM D2898. Use for exterior locations and where indicated.
    - a. Application: Treat items indicated on Drawings, and the following when rated construction is required, unless otherwise indicated:
      - 1) Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
      - 2) Wood sills, sleepers, blocking, furring, stripping, and similar concealed members in contact with masonry or concrete.

- 3) Wood framing and furring attached directly to the interior of below-grade exterior masonry or concrete walls.
  - 4) Wood framing members that are less than 18 inches (460 mm) above the ground in crawlspaces or unexcavated areas.
  - 5) Wood floor plates that are installed over concrete slabs-on-grade.
  - 6) Other locations where preservative treated wood is required and not specifically indicated as "preservative but not fire retardant treated.
3. Interior Type A: Treated materials shall have a moisture content of 28 percent or less when tested according to ASTM D3201/D3201M at 92 percent relative humidity. Use where exterior type is not indicated.
  4. Design Value Adjustment Factors: Treated lumber plywood shall be tested according to ASTM D5516 and design value adjustment factors shall be calculated according to ASTM D6305. Span ratings after treatment shall be not less than span ratings specified.
- C. Kiln-dry material after treatment to a maximum moisture content of 15 percent. Do not use material that is warped or does not comply with requirements for untreated material.
  - D. Identify fire-retardant-treated plywood with appropriate classification marking of qualified testing agency.
  - E. Application: Treat plywood indicated on Drawings, and the following:
    1. Subflooring and underlayment for raised platforms.
    2. Concealed blocking, except for handrails, millwork, cabinets, and windows and door frames.
    3. Roof construction, including parapets, curbs, and railings.
    4. Plywood backing panels.
    5. Wall sheathing.

## **2.5 WALL SHEATHING**

- A. Glass-Mat Gypsum Sheathing: ASTM C1177/C1177M.
  1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Georgia-Pacific Gypsum LLC, or approved equivalent.
  2. Type and Thickness: Regular, 1/2 inch thick.
  3. Size: 48 by 96 inches for vertical installation.
- B. Plywood Sheathing: Exterior, Structural I sheathing.
  1. Locations: Where indicated.
  2. Span Rating: Not less than 16/0.
  3. Nominal Thickness: Not less than 1/2 inch, or as indicated on drawings.

## **2.6 FASTENERS**

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
  1. For roof parapet and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
  1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C1002.

2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C954.

## **2.7 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS**

- A. Sealant for Glass-Mat Gypsum Sheathing: Elastomeric, medium-modulus, neutral-curing silicone joint sealant compatible with joint substrates formed by gypsum sheathing and other materials, recommended by sheathing manufacturer for application indicated and complying with requirements for elastomeric sealants specified in Division 07 Section "Joint Sealants."
  1. **Confirm that sealant is compatible with Air Barrier material.**

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION, GENERAL**

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
  1. Table 2304.9.1, "Fastening Schedule," in the ICC's International Building Code.
  2. ICC-ES evaluation report for fastener.
- D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.
- E. Coordinate wall and parapet sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

### **3.2 GYPSUM SHEATHING INSTALLATION**

- A. Comply with GA-253 and with manufacturer's written instructions.
  1. Fasten gypsum sheathing to cold-formed metal framing with screws.
  2. Install panels with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
  3. Install panels with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.
- C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.
  1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels.

- D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.
  - 1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels.
- E. Seal sheathing joints according to sheathing manufacturer's written instructions.
  - 1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.

### **3.3 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 06 16 00**



## **SECTION 06 40 23 - INTERIOR ARCHITECTURAL WOODWORK**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Interior standing and running trim, including thresholds.
  - 2. Service desks.
  - 3. Display cases.
  - 4. Book Cases.
  - 5. Study carrels and workstation counters.
  - 6. Wood-veneer faced cabinets.
  - 7. Solid-surfacing countertops.
  - 8. Quartz countertops.
  - 9. Solid surfacing window stools.
  - 10. Hardware for woodwork and cabinets described in this section.
  - 11. Closet and utility shelving.
  - 12. Wood furring, blocking, shims, and hanging strips for installing interior architectural woodwork items that are not concealed within other construction.
  - 13. Shop priming of interior architectural woodwork.
  - 14. Shop finishing of interior architectural woodwork.
  - 15. Slotted wood display panels.
  - 16. Adjustable bracket shelving.
  - 17. Coat hooks.
  - 18. Fiberglass reinforced plastic paneling.
  - 19. Fire retardant wood and plywood used as an interior finish material when required by the building code.
- B. Related Requirements:
  - 1. Division 05 Sections "Metal Fabrications" and "Decorative Metal" for exposed, semi-exposed and concealed supports and attachments for Interior Architectural Woodwork if not included in this section.
  - 2. Division 05 Section "Decorative Metal" for perforated aluminum panels for custom millwork.
  - 3. Division 06 Section "Rough Carpentry" for fire retardant wood furring, blocking, shims, and hanging strips required for installing woodwork and concealed within other construction before woodwork installation.
  - 4. Division 06 Section "Sheathing" for fire retardant plywood blocking/sheathing concealed within other construction.
  - 5. Division 06 Section "Plastic Laminate Clad Cabinets."
  - 6. Division 08 Section "Glazing" for glass used in cabinets, book cases and display cases.
  - 7. Division 09 Section "Acoustical Panel Ceilings" for wood ceiling systems that will include custom wood panels specified in this section.
  - 8. Division 09 Section "Painting" for priming and backpriming of interior finish carpentry.
  - 9. Division 10 Section "Visual Display Surfaces" for tackable wall surfaces adjacent to casework specified in this section.
  - 10. Division 26 Sections "Wiring Devices" and "Interior Lighting" and schedule information on electrical drawings for power raceway and task lights installed as part of millwork.

### **1.3 COORDINATION**

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections, to ensure that interior architectural woodwork can be supported and installed as indicated.

### **1.4 PREFABRICATION & PREINSTALLATION MEETINGS**

- A. Pre-fabrication Conference: Conduct conference at Project site to review design intent with Architect, contractor, and fabricator present and identify mock-up locations.
- B. Preinstallation Conference: Conduct conference at Project site prior to installation.

### **1.5 ACTION SUBMITTALS**

- A. Product Data:
  - 1. For panel products, solid-surfacing material, fire-retardant-treated materials, cabinet hardware and accessories, and finishing materials and processes.
  - 2. Anchors.
  - 3. Adhesives.
  - 4. Waterborne Treatments: For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
- B. Shop Drawings:
  - 1. Include the following:
    - a. Dimensioned plans, elevations, and sections.
    - b. Attachment details.
  - 2. Show full-size details.
  - 3. Show locations and sizes of furring, blocking, and hanging strips, including blocking and reinforcement concealed by construction and specified in other Sections.
  - 4. Show locations and sizes of cutouts and holes for grommets, electrical switches and outlets and other items installed in architectural woodwork.
  - 5. Show miscellaneous and decorative metals that are incorporated into work of this section.
  - 6. Apply AWI Quality Certification Program label to Shop Drawings.
- C. Samples for Initial Selection:
  - 1. Shop-applied transparent finishes.
  - 2. Shop-applied opaque finishes.
  - 3. Wood veneers on specified substrates
  - 4. Solid-surfacing materials.
  - 5. Slotted wood display panels.
  - 6. FRP samples.
  - 7. Size:
    - a. Panel Products: 12 inches by 12 inches.
    - b. Lumber Products: Not less than 5 inches wide by 12 inches long, for each species and cut, finished on one side and one edge.
- D. Samples for Verification: For the following:
  - 1. Lumber for Transparent Finish: Not less than 5 inches wide by 12 inches long, for each species and cut, finished on one side and one edge.
  - 2. Veneer Leaves: Representative of and selected from flitches to be used for transparent-finished interior architectural woodwork.
  - 3. Lumber and Panel Products with Shop-Applied Opaque Finish: 5 inches wide by 12 inches long for lumber and 8 by 10 inches for panels, for each finish system and color.
    - a. Finish half of exposed surface.
    - b. Miter joints for standing trim.

4. Exposed cabinet hardware and accessories, one unit for each type and finish.

## **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Fabricator and Installer.
- B. Product Certificates: For each type of product.

## **1.7 CLOSEOUT SUBMITTALS**

- A. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

## **1.8 QUALITY ASSURANCE**

- A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
  1. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.
  2. Installer Qualifications: Fabricator of products and Licensed participant in AWI's Quality Certification Program.
- B. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of interior architectural woodwork.
- C. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.
- D. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  1. Required mockups include, but are not limited to:
    - a. Typical construction details, fabrication and installation tolerances and perforations-extent as directed by Architect during pre-fabrication conference.
    - b. Freestanding mockup : portion of typical custom library service desk : top corner of circulation desk with perforated aluminum panel construction.
    - c. Freestanding mockup : portion of built-in study carrel at curtain wall end of book stacks.
    - d. Freestanding mockup : portion of Special Collections Reading Room book case with glass doors, including all hardware.
  2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
  3. Subject to compliance with requirements, approved in place mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## **1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with the Architectural Woodwork Standards, Section 2.
- B. Do not deliver interior architectural woodwork until painting and similar finish operations that might damage woodwork have been completed in installation areas.
- C. Store woodwork in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.
  1. Handle and store fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions.

## **1.10 FIELD CONDITIONS**

- A. Environmental Limitations: Do not deliver or install interior architectural woodwork until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 25 and 55 percent during the remainder of the construction period.
- B. Field Measurements: Where interior architectural woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings.
  - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being concealed by construction, and indicate measurements on Shop Drawings.
- C. Established Dimensions: Where interior architectural woodwork is indicated to fit to other construction, establish dimensions for areas where woodwork is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

## **1.11 COORDINATION**

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that architectural woodwork can be supported and installed as indicated.

## **PART 2 - PRODUCTS**

### **2.1 ARCHITECTURAL WOODWORK, GENERAL**

- A. Quality Standard: Unless otherwise indicated, comply with the Architectural Woodwork Standards for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.
  - 1. The Contract Documents contain requirements that are more stringent than the Architectural Woodwork Standards. Comply with Contract Documents and Architectural Woodwork Standards.
- B. Interior Standing and Running Trim for Opaque Finish, Including Frames & Jambs:
  - 1. Wood Species: Any closed-grain hardwood.
  - 2. Wood Moisture Content: 5 to 10 percent.
- C. Interior Standing and Running Trim for Transparent Finish, Including Frames, Jambs and Thresholds:
  - 1. Wood Species and Cut: Match species and cut indicated for other types of transparent-finished architectural woodwork located in same area of building unless otherwise indicated.
  - 2. Species: Clear White Maple.
  - 3. Cut: Plain sliced/plain sawn.
  - 4. Wood Moisture Content: 5 to 10 percent.
- D. Hardwood Elements for Millwork:
  - 1. 2 ½" Diameter Solid Clear White Maple Leg
  - 2. No finger jointing.
  - 3. Concealed fasteners, unless noted otherwise in the Drawings.

## **2.2 HARDWOOD SHEET MATERIALS, GENERAL**

- A. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of the Architectural Woodwork Standards for each type of interior architectural woodwork and quality grade specified unless otherwise indicated.
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 made with binder containing no urea formaldehyde.
  4. Particleboard: Straw-based particleboard complying with requirements in ANSI A208.1, Grade M-2, except for density.
  5. Softwood Plywood: DOC PS 1, Medium Density Overlay.
  6. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no urea formaldehyde.
    - a. Noted in Drawings as 'Birch Plywood.'
    - b. Used for painted, exposed surfaces.

## **2.3 FIRE-RETARDANT-TREATED MATERIALS**

- A. General: Where fire-retardant-treated materials are indicated, use materials complying with requirements in this Article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified.
1. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
  2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
  3. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.
- B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood). Use the following treatment type:
1. Exterior Type: Organic-resin-based formulation thermally set in wood by kiln drying.
  2. Interior Type A: Low-hygroscopic formulation.
  3. Mill lumber after treatment within limits set for wood removal that do not affect listed fire-test-response characteristics, using a woodworking plant certified by testing and inspecting agency.
  4. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
  5. Kiln-dry materials before and after treatment to levels required for untreated materials.
- C. Fire retardant treatment for interior finish wood products includes, but may not be limited to:
1. Painted horizontal tongue and groove hardwood wall paneling.
  2. Painted hardwood plywood used as an interior finish.
  3. Wood ceiling panels described in paragraph 2.5 of this section, with both painted and clear finishes.

## **2.4 BALTIC BIRCH CORE MAPLE VENEER PLYWOOD**

- A. Premium veneer core constructed of solid grade, hardwood core, 1/16" Alder and Birch. Uniformly thin core veneers laminated at right angles producing an attractive visual edge.
1. Basis of Design Product: "Appleply", as manufactured by States Industries, or approved equivalent.

2. Thickness: As indicated on Drawings, including  $\frac{3}{4}$ " and 1" thickness.
  - a. Countertops and end panels on custom service desks and millwork call for 1-1/2" and 2-1/4" built-up thicknesses. Corner joinery on waterfall desks requires a layering of  $\frac{3}{4}$ " leaves to achieve stepped detailing. See Drawings.
3. Species and finish:
  - a. Select White Maple, Plain Sliced, Slip Match, Clear Low Luster Finish with UV protection.
4. Veneer grain shall always run the length of any horizontal surface and vertically on vertical surfaces such as table end panels.

## 2.5 WOOD CEILING PANELS

- A. Provide wood veneer panels for installation in ceiling systems specified in Division 09 Section "Acoustical Panel Ceilings."
  1. Wood Panel WD-2
    - a. Hardwood veneer panel, paint grade.
    - b. Panel Size: 12" wide.
    - c. Thickness: To match WD-1.
    - d. Finish: White to match WD-1.
    - e. Provide backing to allow for attachment to suspension system used for ceiling WD-1.
  2. Wood Panel WD-4
    - a. Maple veneer panel. Species, color and graining to match WD-3.
    - b. Panel Size: 12" wide.
    - c. Thickness: To match WD-3.
    - d. Finish: Clear or stained finish to match WD-3.
    - e. Provide backing to allow for attachment to suspension system used for ceiling WD-3.

## 2.6 WOOD CABINETS FOR TRANSPARENT FINISH

- A. Architectural Woodwork Standards Grade: Premium.
- B. Type of Construction: Frameless.
- C. Door and Drawer-Front Style: Flush overlay.
  1. Reveal Dimension: As indicated on Drawings.
- D. Wood for Exposed Surfaces:
  1. Species: Select White Maple.
  2. Cut: Plain sliced/plain sawn.
  3. Grain Direction: Vertically for doors and fixed panels, horizontally for drawer fronts, unless otherwise noted on drawings.
  4. Matching of Veneer Leaves: Slip match.
  5. Veneer Matching within Panel Face: Balance match.
  6. Veneer Matching within Room: Provide cabinet veneers in each room or other space from a single flitch with doors, drawer fronts, and other surfaces matched in a sequenced set with continuous match where veneers are interrupted perpendicular to the grain.
- E. Semiexposed Surfaces:
  1. Surfaces Other Than Drawer Bodies: Same species and cut indicated for exposed surfaces.
  2. Drawer Subfronts, Backs, and Sides: Solid-hardwood lumber, stained to match species indicated for exposed surfaces.
  3. Drawer Bottoms: Hardwood plywood.
- F. Dust Panels: 1/4-inch plywood or tempered hardboard above compartments and drawers unless located directly under tops.

- G. Drawer Construction: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
  - 1. Join subfronts, backs, and sides with glued rabbeted joints supplemented by mechanical fasteners.

## **2.7 SOLID-SURFACING-MATERIAL WINDOW SILLS and COUNTERTOPS**

- A. Window Sills and Countertops:
  - 1. Basis of Design Product: Corian, as manufactured by DuPont, or approved equivalent.
    - a. Non-porous, homogeneous material composed of acrylic polymer, aluminum trihydrate filler and pigment.
  - 2. Grade: Premium.
  - 3. Solid-Surfacing-Material Thickness:
    - a. For Window Sills/Stools: 3/4 inch.
    - b. For Countertops: 3/4 inch, with built up edge as shown in Drawings.
  - 4. Colors, Patterns, and Finishes: Provide materials and products that result in colors of solid-surfacing material complying with the following requirements:
    - a. As selected by Architect from manufacturer's full range of standard and premium products.
    - b. Provide three (3) colors.
  - 5. Fabricate sills in one piece, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.
  - 6. Fabricate sills with shop-applied edges of materials and configuration indicated.

## **2.8 QUARTZ SURFACING COUNTERTOPS**

- A. Countertops:
  - 1. Basis of Design Product: Cambria, or approved equivalent.
    - a. Manmade sheet countertop product made of natural quartz.
  - 2. Grade: Premium.
  - 3. Solid-Surfacing-Material Thickness: nom. 3/8" (1 cm) and nom. 1-1/4 inch (3 cm).
  - 4. Colors, Patterns, and Finishes: Provide materials and products that result in colors of solid-surfacing material complying with the following requirements:
    - a. As selected by Architect from manufacturer's full range of standard and premium products.
    - b. Matte finish.
    - c. Provide three (3) colors.
  - 5. Fabricate Countertops in one piece, unless otherwise indicated. Comply with solid-surfacing-material manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.
    - a. Provide slightly eased edges.
  - 6. Fabricate Countertops with shop-applied edges of materials and configuration indicated.

## **2.9 CLOSET AND UTILITY SHELVING**

- A. Provide the following in Closet 307B.
  - 1. Shelf Material: 3/4-inch solid lumber, full width of closet.
  - 2. Cleats: 3/4-inch solid lumber.
  - 3. Wood Species: Any closed-grain hardwood.
  - 4. Closet Rods: 1-5/16-inch-diameter, aluminum tubes complying with BHMA A156.16, L03131.
  - 5. Rod Flanges: Aluminum.
  - 6. Wood Finish: Painted.
- B. Provide closet rods and flanges noted above in any other location shown in the Drawings.

## 2.10 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, except for items specified in Division 08 Section "Door Hardware."
- B. Frameless Concealed Hinges (European Type), for all locations unless specified otherwise, or noted otherwise in the Drawings.
  - 1. BHMA A156.9, B01602, 170 degrees of opening, self-closing within 10 degrees of cabinet face, with vertical adjustment. Provide two hinges for doors less than 48 inches high and provide three hinges for doors more than 48 inches high.
- C. Hinges for Circulation Desk Gates:
  - 1. McKinney 4" – HS1001 Template by Corbin Russwin, Inc., or approved equivalent.
  - 2. Half Surface Double Acting Spring Hinge.
  - 3. Template 375-98.
  - 4. Door Thickness: 7/8" to 1-1/4" thick.
  - 5. Material: Plated steel.
  - 6. Finish: Dull Chromium US26D.
- D. Pivot Hinges for Glass Cabinet
  - 1. Provide Surface Mount Cabinet Pivot Hinge by C. R. Laurence Co., Inc., or approved equivalent.
    - a. Item FA50SC.
    - b. Surface mounted patch fitting hinges for cabinets.
    - c. For 1/4" to 5/16" glass.
    - d. Finish: Satin Chrome.
- E. Bench Seat Lid Hinge
  - 1. Provide piano hinge configured as shown in Drawings.
  - 2. Width: 1-1/2" flanges.
  - 3. Material: grade 304 stainless steel.
  - 4. Finish: satin.
- F. Bench Seat Lid Stay
  - 1. Provide Adjustable Soft-Down Lid Stay NSDX-20 by Sugatsune, or approved equivalent.
  - 2. Material: Steel.
  - 3. Finish: Nickel.
  - 4. 70 degree opening.
  - 5. Two stays per lid.
- G. Bent Plate Cabinet Pulls: The following cabinet pulls are incorporated into the scope of the project and distinguished graphically in the drawings:
  - 1. Pulls: Top- or side- mounted, solid stainless steel 2 inch long pull.
  - 2. Basis of Design: "Item SN-50/M" by Sugatsune USA, or approved equivalent.
  - 3. Finish: Satin 004.
  - 4. Locations: See Drawings.
- H. Glass Cabinet Knob
  - 1. Provide Single-Sided Cylinder Knobs by C.R. Laurence Co., Inc., or approved equivalent.
  - 2. Item SDK212BSC.
  - 3. Fits 1/4" to 1/2" thick glass.
  - 4. Solid brass, with Brushed Satin Chrome finish.
- I. Bookcase Glass Door Pull
  - 1. Provide Zwei L Knob ZL-1907 by Sugatsune, or approved equivalent.
  - 2. Material: 316 Stainless Steel.
  - 3. Finish: Brushed.
  - 4. Glass Thickness: 6mm.



- J. Glass Door Magnetic Catch
1. Provide XL-GC09-CR by Sugatsune, or approved equivalent.
  2. Top board wood installation method.
  3. Materials: Steel counterplate with Zinc Alloy face plate.
  4. Finish: Chrome.
  5. Black rubber pad for glass installation.
- K. Shelf Rests:
1. Provide CRL Steel Shelf Support by C. R. Laurence Co., Inc., or approved equivalent.
  2. Catalog Number KV346.
  3. Finish: Nickel plated.
  4. Provide rubber cushions for glass shelf locations.
- L. Wall-Mounted Adjustable Bracket Shelving: Basis of Design: "Rakks" Shelving System as manufactured by Rangine Corporation, [www.rakks.com](http://www.rakks.com), or approved equivalent.
1. Wall Standards: "C-Standard:" extruded aluminum wall standard, 0.700 inch by 0.535 inch, suitable for surface or recessed mounted application.
    - a. Size 0.7 inch by 0.535 inch with 9/32" opening to accept all Rakks shelf support brackets.
    - b. Anchors: Manufacturer's standard flat head countersunk not to interfere with brackets. Finish to match wall standards.
  2. Shelf Support Brackets: "Rakks Style" Heavy duty, 12 inches deep unless otherwise noted. Retaining pin option.
  3. Shelf Coupler.
  4. Material: 6063-T6 extruded aluminum.
  5. Finish: White powder coat.
- M. Counter Support Bracket:
1. Basis of Design: "Rakks" EH-Inside Wall Mount Counter Support Bracket as manufactured by Rangine Corporation, [www.rakks.com](http://www.rakks.com), or approved equivalent.
  2. Mount arm of counter support to side of metal studs inside wall prior to installation of gypsum wall board.
  3. Sizes:
    - a. Counter Support: Model EH-1818FM; supports 25" deep counter; 18" x 20" bracket
    - b. Counter Support: Model EH-1824FM; supports 30" deep counter; 18" x 26" bracket
  4. Finish: Custom powder coat in color to match Architect's sample.
- N. Aluminum Z Clip:
1. Basis of Design: Aluminum Z Clip EAM-375-2 by Eagle Mouldings, or approved equivalent.
    - a. 2" long x 1-1/4" tall x .240" stand-off x 3/8" lift off
- O. Drawer Slides: BHMA A156.9, B05091.
1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.
- P. Cabinet Door Locks: BHMA A156.11, E07121 where indicated on drawings.
- Q. Bench Seat Locks: StealthLock Battery Powered Electronic Locking System by Hafele, or approved equivalent.
1. Provide Battery Powered RF Cabinet Lockset and Aluminum Key Pad Mounting Plate.
  2. One key pad transmitter activates several locks within a 15 foot range.
  3. Locks powered by (4) AAA batteries.
  4. Low battery indicator on key pad transmitter and lock
  5. See Drawings for locations of locks and key pad transmitters
- R. Special Collections Book Case & Vitrine Locks

1. Provide XL-GC01 Glass Door Lock for Swinging Double Doors by Sugatsune, or approved equivalent.
  2. Dual locking mechanism that locks and unlocks both doors at once by inserting the key.
  3. Materials: Zinc Alloy Body and counterplate.
  4. Finish: Chrome.
  5. Black synthetic rubber spacer.
  6. Stainless steel screws.
  7. Brass key with nickel finish.
- S. Drawer Locks: BHMA A156.11, E07041 where indicated on drawings.
- T. Coat Hook: Stainless steel hook with concealed suspension hardware.
1. Basis of Design Product: "RM823" by Rockwood; or approved equivalent.
  2. Material: Stainless steel.
  3. Finish: US32D.
  4. In addition to coat hooks shown in millwork Drawings, provide the following:
    - a. One coat hook in each room labeled Office, with exceptions listed below.
    - b. Room 201 - 12 hooks.
    - c. Room 201B - 2 hooks.
    - d. Room 204 - 8 hooks.
    - e. Room 217 - 10 hooks.
    - f. Room 303A - 3 hooks.
    - g. Room 307 - 6 hooks.
    - h. Room 325 - 4 hooks.
    - i. Room 418 - 3 hooks.
    - j. Room 418A - 2 hooks.
    - k. Room 420 - 6 hooks.
  5. For coat hooks mounted on doors, see Division 08 Sections "Door Hardware" and "Door Hardware Sets."
- U. Wood Desk Leveler:
1. Provide the following parts by Hafele, or approved equivalent.
  2. Base Leveler: 651.13.906; steel; 1-1/16" diameter foot; 1/4" stem.
  3. Knock-In Stem: 039-02-065; brass; 1/4" stem.
- V. Aluminum Carrel Leveler:
1. Provide 637.05.300 by Hafele, or approved equivalent.
  2. Material: Steel.
  3. Finish: Zinc plate.
  4. Cap: black plastic.
  5. Slot for screwdriver blade for adjustment from above.
- W. Power Grommet:
1. Provide Flush Power Grommet PCS62B/USB by Mockett, or approved equivalent.
  2. 2 Electric / 2 USB outlets per grommet
  3. Size: 5-3/8" x 2-1/2"
  4. Finish: Satin aluminum plate with black receptacles.
- X. Metal Grommet:
1. Provide MM3A solid brass grommet liner by Mockett, or approved equivalent.
  2. Size: 1-7/8" diameter.
  3. Finish: Satin Chrome 26D.
- Y. Metal Bridle Rings
1. Provide metal bridle rings CJ4T125 by Legrand or approved equivalent.
  2. Size: 1/4" x 1-1/4" diameter.
  3. For bundling of data and power cabling at millwork.

- Z. Velcro Sleeve
  1. Provide WM11 – 4-3/4" Flexible Tube Wire Manager by Mockett or approved equivalent.
  2. Material: Veltex laminated loop fabric with continuous Velcro fasteners
  3. Color: Black
  4. Sizes: Custom lengths as required and as noted on Drawings.
  
- AA. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA finish number indicated (intended to match door hardware).
  1. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
  2. Satin Stainless Steel: BHMA 630
  
- BB. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

## **2.11 FELT ACOUSTICAL FABRIC**

- A. Basis of Design: Performance Nufelt Acoustic Wallcovering.
  1. Thickness: 0.12" (0.3 cm).
  2. Width: 63".
  3. Contents: 100% recycled polyester.
  4. Backing: Fused polyester.
  5. Fire Test: ASTM E84 Class A, CAN/ULC S102.
  6. Sound Absorption: NRC 0.20.
  7. Color: As selected by Architect from manufacturer's full range.
  8. Use: Acoustic material installed behind perf metal panels at service point desks.

## **2.12 SLOTTED WOOD DISPLAY PANELING**

- A. Basis of Design: Provide slotted wood display paneling as manufactured by Slatwall Systems, or approved equivalent.
  
- B. Paneling:
  1. 3/4 inch (19 mm) thick medium density fiberboard grooved to receive standard-sized fixture mounting brackets for display. MDF paneling to be consistent with the following:
  2. Formaldehyde Emission: Less than 0.3 ppm.
  3. Density: 46-48 pounds per cubic foot (737 kg/cu m) average.
  4. Flame Spread: 200, maximum, when tested in accordance with ASTM E 84-94 (Class C, Class III).
  5. Inner Bond Strength: 100 psi to 105 psi average.
  6. Modulus of Rupture: 3500-4000 psi
  7. Modulus of Elasticity: 350,000-400,000 psi
  8. Linear Expansion: 0.24-0.30 percent.
  9. Screw Holding Strength at Edge: 250-275 pounds
  10. Screw Holding Strength at Face: 300 pounds
  11. Moisture Content: 4 to 8 percent.
  12. Thickness Tolerance: plus/minus 0.005 inch (0.13 mm).
  13. Length and Width Tolerance: Plus/Minus 0.0625 inch (1.59 mm).
  14. Squareness Tolerance: 0.0156 inch per linear foot (0.13 mm in 1 m).
  
- C. Slatwall Type:
  1. Slats: T-shaped, spaced at 3 inches (75 mm) on center.
  2. Slat Direction: Parallel to floor, along the length of the panel.
  
- D. Finish:
  1. High pressure plastic laminate, color to be selected from panel manufacturer's standard options.
  
- E. Groove Finish:

1. Extruded aluminum T-shaped insert mill finish.

F. Panel Sizes:

1. Panel Size: 5' x 8' panel.

## 2.13 FIBERGLASS REINFORCED PLASTIC PANELS

A. Manufacturer: Crane Composites, Inc. (formerly Kemlite), Channahon, Illinois, or approved equivalent.

1. Surface-Burning Characteristics: Determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction.
2. Smoke-Developed Index: 450, equal to or less.
3. Warranty Period: 1 year from date of purchase.

B. FM Global (FM) ([www.fmglobal.com](http://www.fmglobal.com)):

1. ANSI FM Approval 4880 – Class 1 Fire Rating of Insulated Wall or Wall and Roof/Ceiling Panels, Interior Finish Materials or Coatings, and Exterior; Wall Systems.

C. UL ([www.ul.com](http://www.ul.com)):

1. UL 2818 – GREENGUARD Certification Program For Chemical Emissions For Building Materials, Finishes And Furnishings.

D. Basis of Design Panel Product: Crane Composites FM Approved “Glasbord FSFM”, or approved equivalent.

1. Class A.
2. Use: Walls.
3. Surface Finish: Smooth.
4. Scratch Resistance, ASTM D 2583, Barcol Hardness: 40.
5. Abrasion Resistance, Taber Abrasion Test, CS-17 abrasive wheels with 1,000 g weight: Weight loss after 25 cycles of no more than 0.038 percent.
6. Impact Strength, ASTM D 5420: 45 in-lbs (5.1 J), showing no visible damage on finish side.

E. Panel Color: As selected by Architect from manufacturer’s full range.

1. Two colors will be used.

F. Panel Dimensions:

1. Nominal Thickness: 0.075 inch.
2. Wall Panel Size: 4 feet x 9 feet.
  - a. No visible horizontal seems in wall board installations.

## 2.14 FRP ACCESSORIES

A. Moldings, Trim, and Caps: 1-piece extruded polypropylene, configured to cover panel edges and corners.

1. Color: Match FRP panels.

B. Panel Adhesive: As recommended by FRP panel manufacturer for required substrates.

1. VOC Content: Maximum 50 g/L.

C. Panel Seam Sealant: Bright white, 2-part urethane sealant, as recommended by FRP panel manufacturer.

1. VOC Content: 0.0 g/L.

## 2.15 TEMPERED FLOAT GLASS

A. Tempered Glass for Cabinet Doors, Book Shelf Doors, Display Case and Shelves: Refer to Division 08 Section “Glazing.”

## **2.16 MISCELLANEOUS MATERIALS**

- A. Provide self-drilling screws for metal-framing supports, as recommended by metal-framing manufacturer.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage.
  - 1. Provide metal expansion sleeves or expansion bolts for post-installed anchors.
  - 2. Use nonferrous-metal or hot-dip galvanized anchors and inserts at inside face of exterior walls and at floors.

## **2.17 FABRICATION**

- A. Fabricate interior architectural woodwork to dimensions, profiles, and details indicated.
  - 1. Ease edges to radius indicated for the following:
    - a. Edges of Solid-Wood (Lumber) Members: 1/16 inch unless otherwise indicated.
- B. Complete fabrication, including assembly, to maximum extent possible before shipment to Project site.
  - 1. Disassemble components only as necessary for shipment and installation.
  - 2. Where necessary for fitting at site, provide allowance for scribing, trimming, and fitting.
  - 3. Notify Architect seven days in advance of the dates and times interior architectural woodwork fabrication will be complete.
  - 4. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled.
    - a. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting.
    - b. Verify that parts fit as intended, and check measurements of assemblies against field measurements indicated on approved Shop Drawings before disassembling for shipment.
- C. 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.
- D. Prepare built-in architectural woodwork to receive electrical, communication, security, data and other equipment to be provided by others. Coordinate with related equipment to build-in cases and boxes where required to conceal within woodwork.

## **2.18 SHOP PRIMING**

- A. Preparations for Finishing: Comply with the Architectural Woodwork Standards for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.
- B. Interior Architectural Woodwork for Opaque Finish: Shop prime with one coat of wood primer as specified in Division 09 Section "Painting."
  - 1. Backpriming: Apply one coat of primer, compatible with finish coats, to concealed surfaces of woodwork.
- C. Interior Architectural Woodwork for Transparent Finish: Shop-seal concealed surfaces with required pretreatments and first coat of finish as specified in Section 09 93 00 "Staining and Transparent Finishing."
  - 1. Backpriming: Apply one coat of sealer, compatible with finish coats, to concealed surfaces of woodwork.

## **2.19 SHOP FINISHING**

- A. Finish interior architectural woodwork with transparent finish at fabrication shop. Defer only final touchup, cleaning, and polishing until after installation.

- B. Preparation for Finishing: Comply with Architectural Woodwork Standards, Section 5 for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing interior architectural woodwork, as applicable to each unit of work.
  - 1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of interior architectural woodwork. Apply two coats to end-grain surfaces.
- C. Transparent Finish:
  - 1. Architectural Woodwork Standards Grade: Premium.
  - 2. Finish: Catalyzed Lacquer.
  - 3. Wash Coat for Closed-Grain Woods: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
  - 4. Staining: Match Architect's sample.
  - 5. Sheen: **Satin, 31-45** gloss units measured on 60-degree gloss meter according to ASTM D523.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Before installation, condition interior architectural woodwork to humidity conditions in installation areas for not less than 72 hours prior to beginning of installation.
- B. Before installing interior architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming of concealed surfaces.

### **3.2 INSTALLATION**

- A. Grade: Install interior architectural woodwork to comply with same grade as item to be installed.
- B. Assemble interior architectural woodwork and complete fabrication at Project site to the extent that it was not completed during shop fabrication.
- C. Install interior architectural woodwork level, plumb, true in line, and without distortion.
  - 1. Shim as required with concealed shims.
  - 2. Install level and plumb to a tolerance of 1/8 inch in 96 inches.
- D. Scribe and cut interior architectural woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Anchor interior architectural woodwork to anchors or blocking built in or directly attached to substrates.
  - 1. Secure with countersunk, concealed fasteners and blind nailing.
  - 2. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with interior architectural woodwork.
  - 3. For shop-finished items, use filler matching finish of items being installed.
- F. Standing and Running Trim:
  - 1. Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible.
  - 2. Do not use pieces less than 96 inches long, except where shorter single-length pieces are necessary.
  - 3. Scarf running joints and stagger in adjacent and related members.
  - 4. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches.

- G. 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. Complete installation of hardware and accessory items as indicated.
1. Install cabinets with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
  2. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.
- H. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
1. Align adjacent solid-surfacing-material countertops and form seams to comply with manufacturer's written recommendations using adhesive in color to match countertop. Carefully dress joints smooth, remove surface scratches, and clean entire surface.
  2. Install countertops with no more than 1/8 inch in 96-inch sag, bow, or other variation from a straight line.
  3. Secure backsplashes to tops with concealed metal brackets at 16 inches o.c. and to walls with adhesive.
  4. Caulk space between backsplash and wall with sealant specified in Division 7 Section "Joint Sealants."
- I. Slotted Wood Display Panel:
1. Store panels laid flat in the area in which they are to be installed for at least 48 hours prior to installation, to acclimate to ambient conditions.
  2. Install panels using adhesive and screws, in accordance with panel manufacturer's/ fabricators instructions.
  3. Use a bead of adhesive the full width of the panel at each stud location.
  4. Locate panel ends over studs.
  5. Screw panels to every other stud and not more than 12 inches on center vertically; install screws in grooves. Flathead, 1-1/2 inches (38 mm) long, minimum
- J. FRP panels:
1. Install in accordance with manufacturer's instructions at locations indicated on the Drawings.
  2. Install FRP panels plumb, level, square, flat, and in proper alignment.
  3. Install FRP panels to be water resistant and washable.
  4. Install FRP panels with manufacturer's recommended gap for panel field and corner joints.
  5. Fasteners:
    - a. Use fasteners in accordance with manufacturer's instructions to install FRP panels securely to supports.
    - b. Pre-drill fastener holes in FRP panels, 1/8 inch (3.2 mm) greater in diameter than fasteners.
  6. Adhesive:
    - a. Install FRP panels in full spread of adhesive.
    - b. Follow adhesive manufacturer's instructions for application of adhesive.
  7. Install trim accessories with adhesive and nails or staples.
    - a. Do not fasten through FRP panels.
  8. Sealant:
    - a. Fill grooves in trim accessories with sealant before installing FRP panels.
    - b. Bed inside corner trim in bead of sealant.
    - c. Remove excess sealant and smears as FRP panels are installed.
    - d. Clean in accordance with sealant manufacturer's instructions.
  9. Tolerances: Install FRP panels within manufacturer's installation tolerances.
- K. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

- L. Refer to Division 09 Sections for final finishing of installed architectural woodwork not indicated to be shop finished.

### **3.3 REPAIR**

- A. Repair damaged and defective interior architectural woodwork, where possible, to eliminate functional and visual defects.
- B. Where not possible to repair, replace defective woodwork.
- C. Shop Finish: Touch up finishing work specified in this Section after installation of interior architectural woodwork.
  - 1. Fill nail holes with matching filler where exposed.
  - 2. Apply specified finish coats, including stains and paste fillers if any, to exposed surfaces where only sealer/prime coats are shop applied.
- D. Field Finish: See Division 09 Section "Painting" for final finishing of installed interior architectural woodwork not indicated to be shop finished.

### **3.4 CLEANING**

- A. Clean interior architectural woodwork on exposed and semiexposed surfaces.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials.
  - 3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.

**END OF SECTION 06 40 23**



## **SECTION 06 41 16 - PLASTIC-LAMINATE-CLAD CABINETS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Plastic-laminate-clad architectural cabinets.
- B. Related Requirements:
  - 1. Division 06 Section "Rough Carpentry" for wood blocking for anchoring casework.
  - 2. Division 06 Section "Interior Architectural Woodwork" for solid surfacing countertops to be installed on plastic laminate cabinets, and for custom and wood veneer millwork.

#### **1.3 COORDINATION**

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to support loads imposed by installed and fully loaded cabinets.

#### **1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Show large-scale details.
  - 3. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
  - 4. Show locations and sizes of cutouts and holes for items installed in plastic-laminate architectural cabinets.
  - 5. Apply AWI Quality Certification Program label to Shop Drawings.
- C. Samples: For each exposed product and for each color and texture specified, in manufacturer's or manufacturer's standard size.
- D. Samples for Initial Selection: For each type of exposed finish.
- E. Samples for Verification: For the following:
  - 1. Plastic Laminates: 8 by 10 inches, for each type, color, pattern, and surface finish required.
    - a. Provide one sample applied to core material with specified edge material applied to one edge.
  - 2. Exposed Cabinet Hardware and Accessories: One full-size unit for each type and finish.

## **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of product.

## **1.7 CLOSEOUT SUBMITTALS**

- A. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

## **1.8 QUALITY ASSURANCE**

- A. Manufacturer's Qualifications: Employs skilled workers who custom fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.
  - 1. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.
- B. Installer Qualifications: Licensed participant in AWI's Quality Certification Program.

## **1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Do not deliver cabinets until painting and similar finish operations that might damage architectural cabinets have been completed in installation areas. Store cabinets in installation areas or in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.

## **1.10 FIELD CONDITIONS**

- A. Environmental Limitations: Do not deliver or install cabinets until building is enclosed, wet-work is complete, and HVAC system is operating and maintaining temperature and relative humidity at levels planned for building occupants during the remainder of the construction period. Maintain temperature and relative humidity during the remainder of the construction period in range recommended for Project location by the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."
- B. Field Measurements: Where cabinets are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  - 1. Locate concealed framing, blocking, and reinforcements that support cabinets by field measurements before being enclosed/concealed by construction, and indicate measurements on Shop Drawings.
- C. Established Dimensions: Where cabinets are indicated to fit to other construction, establish dimensions for areas where cabinets are to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

## **1.11 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace components of casework that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Delamination of components or other failures of glue bond.
    - b. Warping of components.
    - c. Failure of operating hardware.
  - 2. Warranty Period: Five years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Source Limitations: Obtain plastic-laminate-faced cabinets from single manufacturer.

### **2.2 PLASTIC-LAMINATE-CLAD ARCHITECTURAL CABINETS**

- A. Quality Standard: Unless otherwise indicated, comply with the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards" for grades of casework indicated for construction, finishes, installation, and other requirements.
  - 1. Provide labels from AWI certification program indicating that casework complies with requirements of grades specified.
  - 2. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.
- B. Architectural Woodwork Standards Grade: Custom.
- C. Design:
  - 1. Flush overlay.
- D. Exposed Materials:
  - 1. Plastic Laminate: Grade HGS.
    - a. Colors and Patterns: As selected by Architect from manufacturer's full range.
  - 2. Unless otherwise indicated, provide specified edgebanding on all exposed edges.
- E. Semiexposed Materials:
  - 1. Plastic Laminate: Grade VGS unless otherwise indicated. Provide plastic laminate for semiexposed surfaces unless otherwise indicated.
    - a. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.
  - 2. Thermoset Decorative Panels: Provide thermoset decorative panels for semiexposed surfaces unless otherwise indicated.
    - a. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.
  - 3. Hardboard: Use only for cabinet backs where exterior side of back is not exposed.
  - 4. Unless otherwise indicated, provide specified edgebanding on all semiexposed edges.
- F. Concealed Materials:
  - 1. Solid Wood: Any hardwood or softwood species, with no defects affecting strength or utility.
  - 2. Plywood: Hardwood plywood.
  - 3. Plastic Laminate: Grade BKL.
  - 4. Particleboard.
  - 5. MDF.
  - 6. Hardboard.
- G. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
  - 1. As selected by Architect from laminate manufacturer's full range in the following categories:
    - a. Solid colors, matte finish.

## 2.3 MATERIALS

- A. Composite Wood Products: Products shall be made without urea formaldehyde.
- B. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.
- C. Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated.
- D. Softwood Plywood: DOC PS 1.
- E. Particleboard: ANSI A208.1, Grade M-2.
- F. Particleboard: Straw-based particleboard complying with ANSI A208.1, Grade M-2, except for density.
- G. MDF: ANSI A208.2, Grade 130 .
- H. Hardboard: ANSI A135.4, Class 1 Tempered.
- I. Plastic Laminate: High-pressure decorative laminate complying with NEMA LD 3.
- J. Edgbanding for Plastic Laminate: Plastic laminate matching adjacent surfaces.
- K. Adhesives: Do not use adhesives that contain urea formaldehyde.

## 2.4 CABINET HARDWARE AND ACCESSORIES

- A. Hardware, General: Unless otherwise indicated, provide manufacturer's standard satin-finish commercial-quality, heavy-duty hardware.
  - 1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard except where hardware is through-bolted from back side.
- B. Frameless Concealed Hinges (European Type): BHMA A156.9, Type B01602, 170 degrees of opening. Provide two hinges for doors less than 48 inches high and provide three hinges for doors more than 48 inches high.
- C. Pulls: Solid stainless-steel wire pulls, fastened from back with two screws. Provide two pulls for drawers more than 30 inches wide.
  - 1. Wire Pulls: Back mounted, solid stainless steel, 3 ½ inches long, 1 5/16 inches deep, and 5/16 inch in diameter satin finish.
    - a. Manufacturer: Hafele America Company, or approved equivalent.
- D. Door Catches: Powder-coated, nylon-roller spring catch. Provide two catches on doors more than 48 inches high.
- E. Drawer Slides: BHMA A156.9, Type B05091.
  - 1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-overtravel-extension type; zinc-plated, steel ball-bearing slides.
- F. Adjustable Shelf Supports: Single-pin metal shelf rests complying with BHMA A156.9, Type B04013.

## 2.5 FABRICATION

- A. Fabricate architectural cabinets to dimensions, profiles, and details indicated. If not detailed or dimensioned on the Drawings, abide by the below standards.

- B. Plastic-Laminate-Faced Cabinet Construction: As required by referenced quality standard, but not less than the following:
1. Bottoms and Ends of Cabinets, and Tops of Wall Cabinets and Tall Cabinets: 3/4-inch particleboard.
  2. Shelves: 3/4-inch-thick plywood.
  3. Backs of Cabinets: 1/4-inch veneer-core hardwood plywood dadoed into sides, bottoms, and tops where not exposed.
  4. Drawer Fronts: 3/4-inch particleboard.
  5. Drawer Sides and Backs: 1/2-inch solid-wood or veneer-core hardwood plywood with glued dovetail or multiple-dowel joints.
  6. Drawer Bottoms: 1/4-inch hardwood plywood glued and dadoed into front, back, and sides of drawers. Use 1/2-inch material for drawers more than 24 inches wide.
  7. Doors 48 Inches High or Less: 3/4 inch thick, with particleboard or MDF cores and solid-wood stiles and rails.
- C. Filler Strips: Provide as needed to close spaces between cabinets and walls, ceilings, and indicated equipment. Fabricate from same material and with same finish as cabinets.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Before installation, condition cabinets to humidity conditions in installation areas for not less than 72 hours.
- B. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. Architectural Woodwork Standards Grade: Install cabinets to comply with quality standard grade of item to be installed.
- B. Install casework level, plumb, and true; shim as required, using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- C. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within 1/16 inch of a single plane. Align similar adjoining doors and drawers to a tolerance of 1/16 inch. Bolt adjacent cabinets together with joints flush, tight, and uniform.
- D. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within 1/16 inch of a single plane. Fasten to hanging strips, masonry, framing, wood blocking, or reinforcements in walls and partitions. Align similar adjoining doors to a tolerance of 1/16 inch.
- E. Fasten cabinets to adjacent cabinets and to masonry, framing, wood blocking, or reinforcements in walls and partitions to comply with the AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."
- F. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.
- G. Adjust casework and hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.

### **3.3 ADJUSTING AND CLEANING**

- A. Repair damaged and defective cabinets, where possible, to eliminate functional and visual defects. Where not possible to repair, replace architectural cabinets. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean cabinets on exposed and semiexposed surfaces.

### **3.4 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 06 41 16**

## **07 13 24 – PRE-APPLIED SHEET MEMBRANE WATERPROOFING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. The Work of this Section includes, but is not limited to, pre-applied sheet membrane waterproofing that forms an integral bond to poured concrete for the following applications:
  - 1. Horizontal Applications: Membrane applied on prepared subbase prior to placement of concrete slabs.
  - 2. Waterstops.
- B. Related sections include, but are not limited to, the following:
  - 1. Division 03 Section "Cast-In-Place Concrete"

#### **1.2 SUBMITTALS**

- A. Submit manufacturer's product data, installation instructions and membrane samples for approval.
- B. Letter of Verification of Compatibility:
  - 1. Provide letter to verify compatibility of products in this section which come into contact with those listed in the following sections, as shown in the Architectural Drawings:
    - a. Division 07 Section "Fluid-Applied Membrane Air Barriers."
    - b. Division 07 Section "Self-Adhering Sheet Waterproofing."
    - c. Division 07 Section "Thermal Insulation."
  - 2. Provide additional testing as required to verify compatibility.

#### **1.3 REFERENCE STANDARDS**

- A. The following standards and publications are applicable to the extent referenced in the text.
  - 1. American Society for Testing and Materials (ASTM):
    - C 836 Standard Specification for High Solids, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course
    - D 412 Standard Test Methods for Rubber Properties in Tension
    - D 570 Standard Test Method for Water Absorption of Plastics
    - D 903 Standard Test Method for Peel or Stripping Strength of Adhesive Bonds
    - D 1876 Standard Test Method for Peel Release of Adhesives (T-Peel)
    - D 1970 Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
    - D 3767 Standard Practice for Rubber - Measurements of Dimensions
    - D 5385 Standard Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes
    - E 96 Standard Test Methods for Water Vapor Transmission of Materials
    - E 154 Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

#### **1.4 QUALITY ASSURANCE**

- A. Manufacturer: Sheet membrane waterproofing system shall be manufactured and marketed by a firm with a minimum of 20 years experience in the production and sales of sheet membrane waterproofing. Manufacturers proposed for use but not named in these specifications shall submit evidence of ability to meet all requirements specified, and include a list of projects of similar design and complexity completed within the past 5 years.
- B. Installer: A firm which has at least 3 years experience in work of the type required by this section.

- C. **Materials:** For each type of material required for the work of this section, provide primary materials which are the products of one manufacturer.
- D. **Pre-Installation Conference:** A pre-installation conference shall be held prior to commencement of field operations to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Agenda for meeting shall include review of special details and flashing.
- E. **Schedule Coordination:** Schedule work such that membrane will not be left exposed to weather for longer than that recommended by the manufacturer.
- F. Products in this section may be included in freestanding mockups.

## **1.5 DELIVERY, STORAGE AND HANDLING**

- A. Deliver materials in labeled packages. Store and handle in strict compliance with manufacturer's instructions. Protect from damage from weather, excessive temperature and construction operations. Remove and dispose of damaged material in accordance with applicable regulations.

## **1.6 PROJECT CONDITIONS**

- A. Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials used. Proceed with installation only when the substrate construction and preparation work is complete and in condition to receive sheet membrane waterproofing.

## **1.7 WARRANTY**

- A. **Sheet Membrane Waterproofing:** Provide written five year material warranty issued by the membrane manufacturer upon completion of work.
- B. **Labor Warranty:** Provide 2 year warranty from installer.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. **Basis of Design:** Provide the following products, or approved equivalent.
- B. **Pre-applied Integrally Bonded Sheet Waterproofing Membrane:** Preprufe® 300R Plus Membrane [or Preprufe 300 Plus LT Membrane for application temperatures between 25°F (-4°C) and 60°F (+16°C)] by GCP Advanced Technologies Construction Products, a 1.2mm (0.046 in) nominal thickness composite sheet membrane comprising 0.8 mm (0.030 in.) of high density polyethylene film, and layers of specially formulated synthetic adhesive layers. The membrane shall form an integral and permanent bond to poured concrete to prevent water migration at the interface of the membrane and structural concrete. Provide membrane with the following physical properties:

NOTE TO SPECIFIER: Preprufe 300R Plus and Preprufe 300 Plus LT can both be installed at temperatures 25°F (-4°C) and above. For temperatures 25°F (-4°C) to 55°F (13°C) GCP Advanced Technologies Technical Bulletin #16 states the use of Preprufe LT Tape is recommended at all sidelaps when using Preprufe 300R. Alternatively, contractors may elect the use of Preprufe 300LT which does not require the use of Preprufe LT Tape at sidelaps in temperature ranges 25°F (-4°C) to 55°F (13°C). For this reason, GCP Advanced Technologies suggests that both products be incorporated into the specification.

PHYSICAL PROPERTIES FOR PREPRUFE 300R (or 300LT) MEMBRANE:



Property	Test Method	Typical Value
Color		White
Thickness	ASTM D 3767 Method A	1.2 mm (0.046 in.) nominal
Lateral Water Migration Resistance	ASTM D 5385 Modified <sup>1</sup>	Pass at 71 m (231 ft) of hydrostatic head pressure
Low Temperature Flexibility	ASTM D 1970	Unaffected at -29°C (-20°F)
Elongation	ASTM D 412 Modified <sup>2</sup>	500%
Crack Cycling at -23°C (-9.4°F), 100 Cycles	ASTM C 836	Unaffected, Pass
Tensile Strength, film	ASTM D 412	27.6 MPa (4,000 lbs/in. <sup>2</sup> )
Peel Adhesion to Concrete	ASTM D 903 Modified <sup>3</sup>	880 N/m (5.0 lbs/in.)
Lap Adhesion	ASTM D 1876 Modified <sup>4</sup>	880 N/m (5.0 lbs/in.)
Resistance to Hydrostatic Head	ASTM D 5385 Modified <sup>5</sup>	71 m (231 ft)
Puncture Resistance	ASTM E 154	990 N (221 lbs)
Permeance	ASTM E 96 Method B	0.6 ng/Pa x s x m <sup>2</sup> (0.01 perms)
Water Absorption	ASTM D 570	0.5%

Footnotes:

1. Lateral water migration resistance is tested by casting concrete against membrane with a hole and subjecting the membrane to hydrostatic head pressure with water. The test measures the resistance of lateral water migration between the concrete and the blind side waterproofing membrane. A hydrostatic head pressure of 71 m (231 ft) of water is the limit of the apparatus.
  2. Elongation of membrane is run at a rate of 50 mm (2 in.) per minute.
  3. Concrete is cast against the protective coating surface of the membrane and allowed to cure (7 days minimum). Peel adhesion of membrane to concrete is measured at a rate of 50 mm (2 in.) per minute at room temperature.
  4. The test is conducted 15 minutes after the lap is formed as per manufacturer's instructions and run at a rate of 50 mm (2 in.) per minute.
  5. Hydrostatic head tests are performed by casting concrete against the membrane with a lap. Before the concrete sets a 3 mm (0.125 in.) spacer is inserted perpendicular to the membrane to create a gap. The cured block is placed in a chamber where water is introduced to the membrane surface up to a head of 71 m (231 ft) of water which is the limit of the apparatus.
- C. Waterstop: Injectable Waterstop – GCPAT Injecto Tube.
- D. Resin Waterstop Infill Material: Low viscosity polyurethane, DeNeef Injecto Pure.
- E. Gungrade Hydrophilic Waterstop: GCPAT Swellseal WA.
1. To be used over mud slab to terminate waterproofing membrane where new slab is installed adjacent to existing slab.

## PART 3 - EXECUTION

### 3.1 EXECUTION

- A. The installer shall examine conditions of substrates and other conditions under which this work is to be performed and notify the Contractor, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected.

### **3.2 SUBSTRATE PREPARATION**

- A. It is essential to create a sound and solid substrate to eliminate movement during the concrete pour. Substrates must be regular and smooth with no gaps or voids greater than 0.5 in. (12 mm). Grout around all penetrations such as utility conduits, etc. for stability.
  - 1. Horizontal Surfaces - The substrate must be free of loose aggregate and sharp protrusions. Avoid curved or rounded substrates. When installing over earth or crushed stone, ensure substrate is well compacted to avoid displacement of substrate due to traffic or concrete pour. The surface does not need to be dry, but standing water must be removed.

### **3.3 INSTALLATION, HORIZONTAL APPLICATIONS**

- A. Strictly comply with installation instructions in manufacturer's published literature, including but not limited to, the following:
  - 1. Place the membrane HDPE film side to the substrate with the clear plastic release liner facing towards the concrete pour. End laps should be staggered to avoid a build-up of layers.
  - 2. Leave the plastic release liner in position until overlap procedure is completed.
  - 3. Accurately position succeeding sheets to overlap the previous sheet 3 in. (75 mm) along the marked selvedge. Ensure the underside of the succeeding sheet is clean, dry and free from contamination before attempting to overlap.
  - 4. Peel back the plastic release liner from between the overlaps as the two layers are bonded together. Ensure a continuous bond is achieved without creases and roll firmly with a heavy roller.
  - 5. Completely remove the plastic liner to expose the protective coating. Any initial tack will quickly disappear.

### **3.4 WATERSTOP INSTALLATION**

- A. Strictly comply with installation instructions in manufacturer's published literature.

### **3.5 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect completed application of waterproofing.
  - 1. For the duration of the waterproofing installation work, prepare weekly test and inspection reports for submission to Architect/Envelope Consultant, inclusive of the following:
    - a. Commentary on the quality of the surface preparation, including deficiencies and recommended remediation measures for each deficiency in the surface preparation.
    - b. General description of progress including annotated plans indicating locations and areas of completed surface preparation and self-adhering waterproofing installation.
    - c. Representative photographs of installed waterproofing.
    - d. Commentary on quality of work and conformance with the design intent.
    - e. Deficiencies in the workmanship and recommended remediation for each deficiency.

### **3.6 PROTECTION**

- A. Protect membrane in accordance with manufacturer's recommendations until placement of concrete. Inspect for damage just prior to placement of concrete and make repairs in accordance with manufacturer's recommendations.

### **3.7 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Plastic Materials
  - 2. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 07 13 24**

## **07 13 25 – SELF-ADHERING SHEET WATERPROOFING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. All of the Contract Documents, including General and Supplementary Conditions and Division 1 General Requirements, apply to the work of this section.

#### **1.2 SUMMARY**

- A. The work of this section includes, but is not limited to, the following:
  - 1. Rubberized asphalt sheet membrane waterproofing
  - 2. Prefabricated drainage composite
  - 3. Protection board
- B. Related Sections: Other specification sections which directly relate to the work of this section include, but are not limited to, the following:
  - 1. Division 03 Section "Cast-In-Place Concrete"
  - 2. Division 04 Section "Unit Masonry"
  - 3. Division 07 Section "Bituminous Dampproofing"
  - 4. Division 07 Section "Pre-Applied Sheet Membrane Waterproofing"
  - 5. Division 07 Section "Fluid-Applied Membrane Air Barriers"
  - 6. Division 07 Section "Sheet Metal Flashing and Trim"
  - 7. Division 07 Section "Joint Sealants"

#### **1.3 REFERENCE STANDARDS**

- A. The following standards and publications are applicable to the extent referenced in the text.
- B. American Society for Testing and Materials (ASTM)
  - C 836 Standard Specification for High Solids, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course
  - D 412 Standard Test Methods for Rubber Properties in Tension
  - D 570 Standard Test Method for Water Absorption of Plastics
  - D 882 Standard Test Methods for Tensile Properties of Thin Plastic Sheeting
  - D 903 Standard Test Method for Peel or Stripping Strength of Adhesive Bonds
  - D 1876 Standard Test Method for Peel Release of Adhesives (T-Peel)
  - D 1970 Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
  - D 3767 Standard Practice for Rubber - Measurements of Dimensions
  - D 5385 Standard Test Method for Hydrostatic Pressure Resistance of Waterproofing Membranes
  - E 96 Standard Test Methods for Water Vapor Transmission of Materials
  - E 154 Standard Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover

#### **1.4 SUBMITTALS**

- A. Product Data: Submit manufacturer's product data, installation instructions, use limitations and recommendations. Include certification of data indicating VOC (Volatile Organic Compound) content of all components of waterproofing system.
- B. Letter of Verification of Compatibility:
  - 1. Provide letter to verify compatibility of products in this section which come into contact with those listed in the following sections, as shown in the Architectural Drawings:
    - a. Division 07 Section "Fluid-Applied Membrane Air Barriers."

- b. Division 07 Section "Fluid Applied Insulation Coating."
  - c. Division 07 Section "Pre-Applied Sheet Membrane Waterproofing."
  - d. Division 07 Section "Self-Adhering Sheet Waterproofing."
  - e. Division 07 Section "Thermal Insulation," especially spray applied.
  - f. Division 07 Section "Applied Fireproofing."
  - g. Division 07 Section "Polyvinyl-Chloride (PVC) Roof."
  - h. Division 07 Section "Sheet Metal Flashing & Trim."
  - i. Division 07 Section "Flexible Stainless Steel Flashing."
  - j. Division 08 Section "Glazed Alum Curtain Walls," especially the Extruded Silicone Air and Vapor Barrier Transitions.
2. Provide additional testing as required to verify compatibility.
- C. Samples: Submit representative samples of the following for approval:
- 1. Sheet membrane
  - 2. Protection board
  - 3. Prefabricated drainage composite

### **1.5 QUALITY ASSURANCE**

- A. Manufacturer: Sheet membrane waterproofing shall be manufactured and marketed by a firm with a minimum of 20 years experience in the production and sales of self-adhesive sheet membrane waterproofing. Manufacturers proposed for use but not named in these specifications shall submit evidence of ability to meet all requirements specified, and include a list of projects of similar design and complexity completed within the past 5 years.
- B. Installer: A firm which has at least 3 years experience in work of the type required by this section.
- C. Materials: For each type of material required for the work of this section, provide primary materials which are the products of one manufacturer.
- D. Pre-Installation Conference: A pre-installation conference shall be held prior to commencement of field operations to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Agenda for meeting shall include review of special details and flashing.
- E. Products in this section may be included in freestanding mockups.

### **1.6 DELIVERY, STORAGE AND HANDLING**

- A. Deliver materials and products in labeled packages. Store and handle in strict compliance with manufacturer's instructions, recommendations and material safety data sheets. Protect from damage from sunlight, weather, excessive temperatures and construction operations. Remove damaged material from the site and dispose of in accordance with applicable regulations.
  - 1. Do not double-stack pallets of membrane on the job site. Provide cover on top and all sides, allowing for adequate ventilation.
  - 2. Protect mastic and adhesive from moisture and potential sources of ignition.
  - 3. Store drainage composite or protection board flat and off the ground. Provide cover on top and all sides.
- B. Sequence deliveries to avoid delays but minimize on-site storage.

### **1.7 PROJECT CONDITIONS**

- A. Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials and products used.

- B. Proceed with installation only when substrate construction and preparation work is complete and in condition to receive sheet membrane waterproofing.

**1.8 WARRANTY**

- A. Sheet Membrane Waterproofing: Provide written 5 year material warranty issued by the membrane manufacturer upon completion of the work.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Basis of Design: Use the following products, or approved equivalents.
- B. Sheet Membrane Waterproofing: Bituthene® 3000/Low Temperature Membrane by GCP Advanced Technologies Construction Products; a self-adhesive, cold-applied composite sheet consisting of a thickness of 1.4 mm (0.056 in.) of rubberized asphalt and 0.1 mm (0.004 in.) of cross-laminated, high density polyethylene film. Provide rubberized asphalt membrane covered with a release sheet, which is removed during installation. No special adhesive or heat shall be required to form laps.
- C. Sheet Membrane Waterproofing

**PHYSICAL PROPERTIES FOR BITUTHENE 3000/LOW TEMPERATURE MEMBRANE:**

<b>Property</b>	<b>Test Method</b>	<b>Typical Value</b>
<b>Color</b>		<b>Dark gray-black</b>
Thickness	ASTM D 3767 Method A	1.5 mm (0.060 in.) nominal
Flexibility, 180° bend over 25 mm (1 in.) mandrel at -43°C (-45°F)	ASTM D 1970	Unaffected
Tensile Strength, Membrane Die C	ASTM D 412 Modified <sup>1</sup>	2240 kPa (325 lbs/in. <sup>2</sup> ) minimum
Tensile Strength, Film	ASTM D 882 Modified <sup>1</sup>	34.5 MPa (5,000 lbs/in. <sup>2</sup> ) minimum
Elongation, Ultimate Failure of Rubberized Asphalt	ASTM D 412 Modified <sup>1</sup>	300% minimum
Crack Cycling at -32°C (-25°F), 100 Cycles	ASTM C 836	Unaffected
Lap Adhesion at Minimum Application Temperature	ASTM D 1876 Modified <sup>2</sup>	700 N/m (4 lbs/in.) – Bituthene 3000 880 N/m (5 lbs/in.) – Low Temp
Peel Strength	ASTM D 903 Modified <sup>3</sup>	1576 N/m (9 lbs/in.)
Puncture Resistance, Membrane	ASTM E 154	222 N (50 lbs) minimum
Resistance to Hydrostatic Head	ASTM D 5385	60 m (200 ft) of water
Permeance	ASTM E 96, Section 12 – Water Method	2.9 ng/m <sup>2</sup> sPa (0.05 perms) maximum
Water Absorption	ASTM D 570	0.1% maximum

Footnotes:

1. The test is run at a rate of 50 mm (2 in.) per minute.
2. The test is conducted 15 minutes after the lap is formed and run at a rate of 50 mm (2 in.) per minute at -4°C (25°F).
3. The 180° peel strength is run at a rate of 300 mm (12 in.) per minute.

- D. Prefabricated Drainage Composite: (Hydroduct® 220) (Hydroduct® 660) Drainage Composite by GCP Advanced Technologies Construction Products. Drainage Composite shall be designed to promote positive drainage while serving as a protection course.

NOTE TO SPECIFIER: The following are product selection guidelines for Hydroduct Drainage Composites. Consult the "Product Summary" and "System Components" section of the Waterproofing Systems Manual North American Edition for complete information. Hydroduct 220: All vertical applications. Hydroduct 660: All horizontal applications. THE APPROPRIATE HYDRODUCT DRAINAGE COMPOSITE MAY ALSO SERVE AS PROTECTION FOR ALL BITUTHENE MEMBRANES.

- E. This product intended for vertical application against below grade walls.
1. Geotextile-Faced, Wall-Insulation Drainage Panels: Extruded-polystyrene board insulation complying with ASTM C 578, Type VI, 40-psi minimum compressive strength; fabricated with tongue-and-groove edges and with one side having grooved drainage channels faced with nonwoven geotextile filter fabric.
  2. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Owens Corning Insulating Systems LLC; Insul-Drain.
    - b. Thickness: 2 1/4 inches minimum thickness.
- F. Waterstop: Adcor™ ES hydrophilic non-bentonite waterstop by GCP Advanced Technologies Construction Products for non-moving concrete construction joints.
- G. Miscellaneous Materials: Surface conditioner, mastic, liquid membrane, tape and accessories specified or acceptable to manufacturer of sheet membrane waterproofing.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. The installer shall examine conditions of substrates and other conditions under which this work is to be performed and notify the contractor, in writing, of circumstances detrimental to the proper completion of the work. Do not proceed with work until unsatisfactory conditions are corrected.

#### **3.2 PREPARATION OF SUBSTRATES**

- A. Refer to manufacturer's literature for requirements for preparation of substrates. Surfaces shall be structurally sound and free of voids, spalled areas, loose aggregate and sharp protrusions. Remove contaminants such as grease, oil and wax from exposed surfaces. Remove dust, dirt, loose stone and debris. Use repair materials and methods which are acceptable to manufacturer of sheet membrane waterproofing.
- B. Cast-In-Place Concrete Substrates:
1. Do not proceed with installation until concrete has properly cured and dried (minimum 7 days for normal structural concrete and minimum 14 days for lightweight structural concrete).

NOTE TO SPECIFIER: If time is critical Bituthene® Primer B2 may be used to allow priming and installation of membrane sooner than 7 days. Priming may begin in this case as soon as the concrete will maintain structural integrity.

2. Fill form tie rod holes with concrete and finish flush with surrounding surface.
3. Repair bugholes over 13 mm (0.5 in.) in length and 6 mm (0.25 in.) deep and finish flush with surrounding surface.
4. Remove scaling to sound, unaffected concrete and repair exposed area.
5. Grind irregular construction joints to suitable flush surface.

- C. Masonry Substrates: Apply waterproofing over concrete block and brick with smooth trowel-cut mortar joints or parge coat.
- D. Wood Substrates: Apply waterproofing membrane over securely fastened sound surface. All joints and fasteners shall be flush to create a smooth surface.
- E. Related Materials: Treat joints and install flashing as recommended by waterproofing manufacturer.

### **3.3 INSTALLATION**

- A. Refer to manufacturer's literature for recommendations on installation, including but not limited to, the following:
  - 1. Apply primer at rate recommended by manufacturer. Recoat areas not waterproofed if contaminated by dust. Mask and protect adjoining exposed finish surfaces to protect those surfaces from excessive application of primer.
  - 2. Delay application of membrane until primer is completely dry. Dry time will vary with weather conditions.
  - 3. Seal daily terminations with troweled bead of mastic.
  - 4. Apply protection board and related materials in accordance with manufacturer's recommendations.

### **3.4 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect completed application of waterproofing.
  - 1. For the duration of the waterproofing installation work, prepare weekly test and inspection reports for submission to Architect/Envelope Consultant, inclusive of the following:
    - a. Commentary on the quality of the surface preparation, including deficiencies and recommended remediation measures for each deficiency in the surface preparation.
    - b. General description of progress including annotated plans indicating locations and areas of completed surface preparation and self-adhering waterproofing installation.
    - c. Representative photographs of installed waterproofing.
    - d. Commentary on quality of work and conformance with the design intent.
    - e. Deficiencies in the workmanship and recommended remediation for each deficiency.

### **3.5 CLEANING AND PROTECTION**

- A. Remove any masking materials after installation. Clean any stains on materials which would be exposed in the completed work.
- B. Protect completed membrane waterproofing from subsequent construction activities as recommended by manufacturer.

### **3.6 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.



C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 07 13 25**

## **SECTION 07 21 00 - THERMAL INSULATION**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Extruded polystyrene foam-plastic board.
  - 2. Polyisocyanurate foam-plastic board.
  - 3. Mineral-wool board.
  - 4. Mineral-wool blanket.
  - 5. Spray-applied polyurethane foam insulation.
- B. Related Requirements:
  - 1. Division 07 Section "Polyvinyl-Chloride (PVC) Roofing" for insulation specified as part of roofing construction.
  - 2. Division 07 Section "Self-Adhering Sheet Waterproofing" for insulation panels and insulated drainage panels installed with waterproofing.
  - 3. Division 07 Section "Penetration Firestopping" for insulation installed as part of a perimeter fire-resistive joint system.
  - 4. Division 08 Section "Glazed Aluminum Curtain Wall" for framing to receive mineral wool board spandrel insulation.
  - 5. Division 09 Section "Gypsum Board" for sound attenuation blanket used as acoustic insulation.

#### **1.3 ACTION SUBMITTALS**

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

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- B. Evaluation Reports: For foam-plastic insulation, from ICC-ES.
- C. Letter of Verification of Compatibility:
  - 1. Provide letter to verify compatibility of products in this section which come into contact with those listed in the following sections, as shown in the Architectural Drawings:
    - a. Division 07 Section "Fluid-Applied Membrane Air Barriers."
    - b. Division 07 Section "Fluid Applied Insulation Coating."
    - c. Division 07 Section "Pre-Applied Sheet Membrane Waterproofing."
    - d. Division 07 Section "Self-Adhering Sheet Waterproofing."
    - e. Division 07 Section "Thermal Insulation," especially spray applied.
    - f. Division 07 Section "Applied Fireproofing."
    - g. Division 07 Section "Polyvinyl-Chloride (PVC) Roof."
    - h. Division 07 Section "Sheet Metal Flashing & Trim."
    - i. Division 07 Section "Flexible Stainless Steel Flashing."
    - j. Division 08 Section "Glazed Alum Curtain Walls," especially the Extruded Silicone Air and Vapor Barrier Transitions.
  - 2. Provide additional testing as required to verify compatibility.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
  - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
  - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
  - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

## PART 2 - PRODUCTS

### 2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD

- A. Extruded polystyrene boards in this article are also called "XPS boards." Roman numeral designators in ASTM C578 are assigned in a fixed random sequence, and their numeric order does not reflect increasing strength or other characteristics.
- B. Extruded Polystyrene Board, Type IV: ASTM C578, Type IV, 25-psi minimum compressive strength; unfaced; maximum flame-spread and smoke-developed indexes of 25 and 450, respectively, per ASTM E84.

### 2.2 POLYISOCYANURATE FOAM-PLASTIC BOARD

- A. Polyisocyanurate Board, Foil Faced: ASTM C1289, foil faced, Type I, Class 2.
  - 1. Provide THERMAX (ci) Exterior Insulation board by The Dow Chemical Company, or approved equivalent.
    - a. Glass-fiber-reinforced polyisocyanurate foam core faced with nominal 1.25 mil embossed blue thermoset-coated aluminum on one side and 0,9 mil smooth, reflective aluminum on the other.
    - b. Thermal Resistance: ASTM C518.
      - 1) R Value/1 inch at 75 deg F: R 6.5.
      - 2) R Value/1 inch at 25 deg F: R 6.8.
    - c. Compressive Strength, ASTM D1621: 25.0 psi.
    - d. Flexural Strength, ASTM C203: 55.0 psi.
    - e. Water Absorption, ASTM C209: 0.1 % by volume, max.
    - f. Water Vapor Permeance, ASTM E96: 0.04 perms, max.
    - g. Surface Burning Characteristics, ASTM E84:
      - 1) Flame spread: 25.
      - 2) Smoke developed: less than 450.
  - 2. Code Compliances:
    - 1) 2012 International Building Code (IBC) Section 2603
      - a) UL Classified; Class A UL 723 (ASTM E84) Surface Burning Characteristics of Building Materials
      - b) Fire Performance Evaluation approvals per NFPA 285, 2006 Edition (UBC 26.9, intermediate scale – multistory testing) as part of an approved assembly
    - 2) ICC-ES ESR-1659
    - 3) FM DS 1-12 – Ceilings and Concealed Spaces, compliant as an FM approved Class 1 Foil-faced Polyisocyanurate Insulation in Cavity Walls
    - 4) FM 4880 – Factory Mutual Class 1 Insulated Wall and Ceiling Panel
    - 5) THERMAX™ products are covered under Underwriters Laboratories Inc. (UL) file R5622

### 2.3 MINERAL-WOOL BOARD

- A. Mineral-Wool Board, Type IVB, Unfaced: ASTM C612; board insulation for cavity wall.
  - 1. Provide Rockwool Cavityrock, or approved equivalent.
    - a. Fire Performance:
      - 1) Non-Combustibility: To ASTM E136.
      - 2) Surface Burning Characteristics: To ASTM E84.
        - a) Flame Spread: 0.
        - b) Smoke Developed: 0.
    - b. Thermal Resistance: To ASTM C518.
      - 1) R Value/1 inch at 75 deg F: R 4.3.
    - c. Water vapor permeance: 27.2 Perm min.
    - d. Moisture absorption: 1% max to ASTM C1104/C1104M.
    - e. Fungi resistance: Zero mold growth to ASTM C1338.
    - f. Corrosive resistance:
      - 1) Steel to ASTM C665: Pass.
      - 2) Stainless steel to ASTM C795: Pass.
    - g. Thickness: 4" unless otherwise noted on Drawings.
    - h. Locations: Including, but not limited to, curtainwall spandrel panels and exterior metal composite metal soffit panels.

### 2.4 MINERAL-WOOL BLANKETS

- A. Mineral-Wool Blanket, Unfaced: ASTM C665, Type I (blankets without membrane facing); lightweight, semi-rigid, consisting of fibers.
  - 1. Provide Rockwool Comfortbat, or approved equivalent.
    - a. Fire Performance:
      - 1) Non-Combustibility: To ASTM E136.
      - 2) Surface Burning Characteristics: To ASTM E84.
        - a) Flame Spread: 0.
        - b) Smoke Developed: 0.
    - b. Thermal Resistance: To ASTM C518.
      - 1) R Value/1 inch at 75 deg F: R 4.0.
    - c. Thickness: as shown on Drawings.

### 2.5 CLOSED-CELL SPRAY POLYURETHANE FOAM

- A. Closed-Cell Spray Polyurethane Foam: ASTM C1029, Type II, minimum density of 1.5 lb/cu. ft. and minimum aged R-value at 1-inch thickness of 6.2 deg F x h x sq. ft./Btu at 75 deg F.
  - 1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
    - a. Flame-Spread Index: 25 or less.
    - b. Smoke-Developed Index: 450 or less.
  - 2. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
- B. Low Expansion Spray Polyurethane Foam: Provide low pressure-build flexible polyurethane foam for sealing window and door gaps, and as noted in the Drawings.
  - 1. Basis of Design: Great Stuff Pro Window and Door Insulating Foam Sealant as manufactured by Dow Building Solutions, or approved equivalent.

### 2.6 INSULATION FASTENERS

- A. Mechanically Attached, Spindle-Type Anchors for Mineral Wool Board Cavity Insulation:
  - 1. Provide manufacturer's proprietary mechanical attachment system, that is:
    - a. Appropriate for type of substrate
    - b. Capable of withstanding applied pull-out and shear loads

- c. Numerous enough and of large enough cross section to prevent tear-through of the insulation under expected conditions
- d. Suitable for use in an exterior application

## **2.7 ACCESSORIES**

- A. Insulation for Miscellaneous Voids:
  - 1. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

### **3.2 INSTALLATION, GENERAL**

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

### **3.3 INSTALLATION OF FOUNDATION WALL INSULATION**

- A. Butt panels together for tight fit.
- B. Anchor Installation: 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.
  - 2. Apply insulation standoffs to each spindle to create cavity width indicated on Drawings 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.
  - 4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.
- C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

### **3.4 INSTALLATION OF CAVITY-WALL INSULATION**

- A. Foam-Plastic Board Insulation: Install pads of adhesive spaced approximately 24 inches 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.
- B. Mineral Wool Board Insulation: Follow manufacturer's recommendations for mechanically attached spindle fasteners.

### **3.5 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION**

- A. Blanket Insulation: Install 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 the cavities, 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 clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
  - 4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
  - 1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

### **3.6 INSTALLATION OF CURTAIN-WALL INSULATION**

- A. Install board insulation in curtain-wall construction according to curtain-wall manufacturer's written instructions, maintaining recommended minimum cavity between insulation and glass.
  - 1. Hold insulation in place with prefinished aluminum sheet metal pan using method recommended in writing by insulation manufacturer.
  - 2. Install insulation to fit snugly without bowing.

### **3.7 PROTECTION**

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation cannot be concealed and protected by permanent construction immediately after installation.

### **3.8 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 07 21 00**

## **SECTION 07 21 63 – FLUID APPLIED INSULATION COATING**

### **PART 1 - GENERAL**

#### **1.1 DESCRIPTION OF WORK**

- A. Section includes a spray-applied insulative coating including primer and insulative coating for the following applications:
  - 1. Applied to steel penetrating the exterior envelope without a physical thermal break, from 24 inches outboard of the face of the wall to 24 inches inside the face of metal framing.

#### **1.2 RELATED SECTIONS**

- A. Division 05 Section “Structural Steel Framing” for structural steel to receive fluid-applied insulation coating, and coordination of steel primers with insulation coating.
- B. Division 05 Section “Metal Fabrications” for structural steel to receive fluid-applied insulation coating, and coordination of steel primers with insulation coating.
- C. Division 07 Section “Thermal Insulation” for building insulation.
- D. Division 09 Section “Painting.”

#### **1.3 REFERENCES**

- A. American Institute of Steel Construction (AISC)
  - 1. AISC 303-05 Section 10 – Erection and storage of coated material during shipment and site handling shall be protected to minimize field touch up.
- B. American Society of Testing and Materials (ASTM)
  - 1. ASTM B117 – Standard Practice for Operating Salt Spray (Fog) Apparatus
  - 2. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
  - 3. ASTM C1057 – Standard Practice for Determination of Skin Contact Temperature from Heated Surfaces Using a Mathematical Model and Thermesthesiometer.
  - 4. ASTM D870 – Standard Practice for Testing Water Resistance of Coatings Using Water Immersion.
  - 5. ASTM D4060 – Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
  - 6. ASTM D4541 – Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
  - 7. ASTM D4585 – Standard Practice for Testing Water Resistance of Coatings Using Controlled Condensation.
  - 8. ASTM D4587 – Standard Practice for Fluorescent UV-Condensation Exposures of Paint and Related Coatings.
  - 9. ASTM D4624/ISO 4624 – Standard Test Method for Bond Strength
  - 10. ASTM D5894 – Standard Practice for Cyclic Salt Fog/UV Exposure of Painted Metal, (Alternating Exposures in a Fog/Dry Cabinet and a UV/Condensation Cabinet).
  - 11. ASTM D638 – Standard Test Method for Tensile Strength
  - 12. ASTM D695 – Standard Test Method for Compressive Strength
  - 13. ASTM D790 – Standard Test Method for Flexural Strength
  - 14. ASTM D2240 – Standard Test Method for Determining Durometer Hardness
  - 15. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials.
  - 16. ASTM E119 – Standard Test Methods for Fire Tests of Building Construction and Materials.

- C. Association of the American Walls and Ceilings Industries (AWCI)
- D. Underwriters Laboratory (UL):
  - 1. UL 263: Standard for Fire Tests of Building Construction and Materials.
- E. The Society of Protective Coatings (SSPC)
  - 1. SSPC-SP6: Commercial Blast Cleaning Standard
  - 2. SSPC-PA1: Shop, Field, and Maintenance Painting of Steel.
  - 3. SSPC-PA2: Procedure for Determining Conformance to Dry Coating Thickness Requirements.

#### **1.4 SYSTEM DESCRIPTION**

- A. The liquid applied thermal break acrylic material shall be applied at the required thickness specified by the manufacturer in order to mitigate thermal bridging. In no case shall the K-value of the liquid applied thermal break be more than 0.040 W/mK.

#### **1.5 SUBMITTALS**

- A. Product Data: Submit product data including manufacturers technical data indicating product performance characteristics, performance and limitation criteria.
- B. Letter of Verification of Compatibility:
  - 1. Provide letter to verify compatibility of products in this section which come into contact with those listed in the following sections, as shown in the Architectural Drawings:
    - a. Division 07 Section "Fluid-Applied Membrane Air Barriers."
    - b. Division 07 Section "Fluid Applied Insulation Coating."
    - c. Division 07 Section "Pre-Applied Sheet Membrane Waterproofing."
    - d. Division 07 Section "Self-Adhering Sheet Waterproofing."
    - e. Division 07 Section "Thermal Insulation," especially spray applied.
    - f. Division 07 Section "Applied Fireproofing."
    - g. Division 07 Section "Polyvinyl-Chloride (PVC) Roof."
    - h. Division 07 Section "Sheet Metal Flashing & Trim."
    - i. Division 07 Section "Flexible Stainless Steel Flashing."
    - j. Division 08 Section "Glazed Alum Curtain Walls," especially the Extruded Silicone Air and Vapor Barrier Transitions.
  - 2. Provide additional testing as required to verify compatibility.
- C. Installation Details: Submit installation details prepared by the manufacturer all locations to receive fluid-applied insulation coatings.
- D. Manufacturer's Instructions: Submit manufacturer written installation instructions.
- E. Applicator Qualifications: Submit applicators current certification as a manufacturer trained applicator.

#### **1.6 QUALITY ASSURANCE**

- A. Manufacturer:
  - 1. Company specializing in manufacturing product in this section with a minimum of 2 years documented experience in manufacturing insulative technology.
  - 2. Applicator: Company specializing in applying the work of this section with documented experience and trained by the manufacturer.
  - 3. Fluid Applied Thermal Break Acrylic system shall be the complete system from a sole source consisting of primer, acrylic thermal break material and topcoat. All materials shall be LEED 2009 compliant.
- B. Mock-up:



1. Minimum thirty days prior to application in any area, provide mock-up Samples of thermal break materials in accordance with the following requirements:
  - a. Provide minimum two square feet on representative substrate, where directed by the Architect, for each different thickness and finish of required for the work.
  - b. Provide mock-up areas that comply with thickness, density application, finish texture, and color.
  - c. Inspect mock-up areas within one hour of application for variance due to shrinkage, temperature, and humidity.
  - d. Where shrinkage and cracking are evident, adjust mixture and method of application as necessary to meet required installation, finish, and color requirements.
  - e. Continue to provide mock-up areas until acceptable areas are produced.
  - f. Acceptable areas shall constitute standard of acceptance for method of application, thickness, finish texture, and color requirements, for fluid applied thermal break material applications.

#### **1.7 DELIVERY, STORAGE AND HANDLING**

- A. Delivery: Deliver materials in manufacturers' original, sealed, undamaged container with identification label intact. Packaged materials shall bear the appropriate labels, seals.
- B. Storage: Materials shall be stored in strict accordance with manufacturers documented instructions.
- C. Documentation: All batch number, product identification and quantities shall be recorded on appropriate QC documents. A copy of the transport document and manufacturers conformance certificate shall be attached to the material delivery on site.

#### **1.8 PROJECT/SITE CONDITIONS**

- A. Project Environmental Requirements: Substrate and air temperature shall be in accordance with the manufacturers' requirements.
  1. Protect work area from windblown dust and rain. Protect adjacent areas from over spray of material.
  2. Provide ventilation in areas to receive work of this section during application and minimum 24 hours after application.
- B. Temperature and Humidity Requirements: Maintain air temperature and relative humidity in areas where products will be applied for a time period before during and after application as recommended by manufacturer.
  1. Do not apply Fluid Applied Acrylic Thermal Break when temperature of substrate and/or surrounding ambient air temperature is below 45° F. Temporary protection and heat shall be maintained at this minimum temperature for 24 hours before, during and 24 hours after material application.
  2. Steel substrate temperature shall be a minimum of 5° F (3° C) above the dew point of the surrounding air for a period of 24 hours prior, during the application of the material and 24 hour cure period.
  3. If necessary for job schedule, the Prime General Contractor shall provide enclosures and heat to maintain proper temperatures and humidity levels in the application areas.
  4. The relative humidity of the application area shall not exceed a maximum of 85% 24 hours prior, during and 24 hours after the application of the material. The relative humidity shall not exceed 75% throughout the application and curing of the decorative top coat finish.

## **PART 2 - PRODUCTS**

### **2.1 FLUID APPLIED INSULATION COATING GENERAL**

#### **A. Materials Compatibility:**

1. Provide shop and field primers, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
2. Provide products of same manufacturer for each coat in a coating system.

### **2.2 MANUFACTURERS**

#### **A. Products specified are manufactured by Tnemec Company Incorporated, and are specified as a standard of quality for approved equivalents.**

1. Provide "Series 971 Aerolon Acrylic" fluid-applied acrylic insulation and compatible primers, or products that meet or exceed the physical and performance requirements of the specified product.

### **2.3 PRIMERS**

#### **A. Water-Based Cementitious Epoxy:**

1. Tnemec Series 1224 Epoxoline WB, or approved equivalent.
  - a. VOC Content: 1 gram/liter
  - b. Color: 1288 Off-White
  - c. Requirements:
    - 1) Abrasion (ASTM D4060): No more than 149 mg loss after 1,000 cycles.
    - 2) Adhesion to Steel (ASTM D4541): No less than 1,989 psi after 10 freeze/thaw cycles.
    - 3) Humidity Resistance (ASTM D4585): No blistering, cracking, rusting, or delamination after 2,000 hours.
    - 4) CDPH Compliant: Passes the California Department of Public Health (CDPH) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, Version 1.1-2010 (also known as Section 01350).

#### **B. Mio-Zinc Filled Aromatic Polyurethane:**

1. Tnemec Series 394-0250 PerimePrime, or approved equivalent.
  - a. VOC Content: 246 grams/liter
  - b. Color: 0250 Greenish-Gray
  - c. Requirements:
    - 1) Adhesion to Steel (ASTM D4541): No less than 1,150 psi.
    - 2) Fire Testing (UL 263, ASTM E119): Any UL Classified spray-applied fire resistive materials having a maximum average density of 19.5 pcf. Including W.R. Grace Monokote MK-6/HY and Isolatek (Cafco) Blaze-Shield II (Type II).
    - 3) Salt Fog Corrosion (ASTM B117): No cracking or delamination of film. No more than 1/64" rust creepage at scribe and no more than 3% rusting on plane after 10,250 hours exposure.
    - 4) Slip Coefficient & Tension Creep: Meets AISC requirements of a Class B surface with a mean slip coefficient no less than 0.57.
    - 5) CDPH Compliant: Passes the California Department of Public Health (CDPH) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, Version 1.1-2010 (also known as Section 01350).

## 2.4 THERMAL INSULATING COATING

- A. Fluid Applied Acrylic Insulation Coating
  - 1. Tnemec Series 971 Aerolon Acrylic or approved equivalent.
    - a. VOC Content: 1.9 grams/liter
    - b. Solids by Volume: 76 percent.
    - c. Colors: 1278 Insulation Yellow
    - d. Dry Film Thickness: 30.0 to 50.0 mills per coat.
    - e. Total Thickness: Minimum of 100.0 mils providing an R value of 0.40 unless noted otherwise.
    - f. Requirements:
      - 1) Abrasion (ASTM D4060): No more than 50.2 mg loss after 1,000 cycles.
      - 2) Cyclic Salt Fog/UV Exposure (ASTM D5894): No blistering, cracking, rusting or delamination of film after 5,000 hours.
      - 3) Humidity Resistance (ASTM D4585): No blistering, cracking, rusting, or delamination after 2,000 hours.
      - 4) Immersion (ASTM D870): No blistering, cracking, rusting, or delamination after six months continuous tap water immersion.
      - 5) Surface Burning Characteristics (ASTM E84): Class A
      - 6) Thermal Conductivity (ASTM C518): No greater than 0.2468 BTU-in/ft<sup>2</sup>-hr-°F.
      - 7) NORSOK M-501 ISO 20340: Passed 25 cycles.
      - 8) CDPH Compliant: Passes the California Department of Public Health (CDPH) Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers, Version 1.1-2010 (also known as Section 01350).

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Fluid applied insulation coating is to be applied to steel framing from 24 inches outboard of the face of the wall to 24 inches inside the face of metal wall framing. Do not begin installation until substrates have been properly prepared.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. All surfaces to receive the specified Tnemec Series 971 Aerolon® shall follow the manufacturer's printed instructions and be clean, dry and free of oil, grease, loose mill scale, dirt, dust or other foreign substances which would impair bond of the material to the substrate.
- D. Other corrections of the surfaces to receive the Fluid Applied Insulation Coating material shall be the responsibility of the Contractor, at no additional cost to the Owner.
- E. Application of the primer, Series 971 Aerolon®, and topcoat shall not commence until the contractor, applicator and inspector have examined the surfaces to receive the primer and determined the surfaces are acceptable to receive the primer and Aerolon®. Commencement of application means acceptance of substrate.
- F. Verify that substrate and workspace temperature and humidity conditions are in accordance with manufacturers recommendations.

### 3.2 SURFACE PREPARATION

- A. Prepare surfaces in accordance with manufacturer's instructions.

- B. Provide masking, drop cloths or other suitable coverings to prevent overspray onto surfaces not intended to be coated with thermal break coating.
- C. Weld spatter and defects shall be ground smooth prior to commencement of primer and fluid applied thermal break material.
- D. Primer shall not be applied to prepared substrate until the area has been adequately vented to remove all airborne dust. Prior to the application of any coating material, the blast products, dust and debris shall be removed by vacuuming.
- E. Steel Substrates: Remove rust and loose mill scale.
  - 1. Fabrication defects:
    - a. Correct steel and fabrication defects revealed by surface preparation.
    - b. Remove weld spatter and slag.
    - c. Round sharp edges and corners of welds to a smooth contour.
    - d. Smooth weld undercuts and recesses.
    - e. Grind down porous welds to pinhole-free metal.
    - f. Remove weld flux from surface.
  - 2. Ensure surfaces are dry.
  - 3. Remove visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter in accordance with SSPC-SP 6/NACE 3, unless otherwise specified.
- F. Abrasive Blast-Cleaned Surfaces: Coat abrasive blast-cleaned surfaces with primer before visible rust forms on surface. Do not leave blast-cleaned surfaces uncoated for more than 8 hours.
  - 1. Shop Primer: Prepare shop primer to receive field coat in accordance with manufacturer's instructions.

### **3.3 APPLICATION**

- A. Apply coatings in accordance with manufacturer's instructions.
  - 1. Mix and thin coatings, including multi-component materials, in accordance with manufacturer's instructions.
  - 2. Keep containers closed when not in use to avoid contamination.
  - 3. Do not use mixed coatings beyond pot life limits.
  - 4. Use application equipment, tools, pressure settings, and techniques in accordance with manufacturer's instructions.
- B. Uniformly apply coatings at spreading rate required to achieve specified DFT.
- C. Apply coatings to be free of film characteristics or defects that would adversely affect performance or appearance of coating systems.
- D. Apply primer at thickness recommended by manufacturer.
- E. Apply Series 971 Aerolon® Thermal Insulative Coating as specified in Section 3.8 Coating Schedule.
- F. Final Dry Film Thickness (DFT) shall be measured with a dry film thickness gauge.
- G. The steel deck is not to be sprayed unless otherwise indicated.

### **3.4 REPAIR**

- A. Materials and Surfaces Not Scheduled to Be Coated: Repair or replace damaged materials and surfaces not scheduled to be coated.

- B. Damaged Coatings: All patching and repair to material, due to damage by other trades, shall be performed under this section and paid for by the trade responsible for the damage. Patching shall be performed by applicators certified by the manufacturer and applied in accordance with the manufacturer application instructions.
- C. Coating Defects: Repair in accordance with manufacturer's instructions coatings that exhibit film characteristics or defects that would adversely affect performance or appearance of coating systems.

### **3.5 FIELD QUALITY CONTROL**

- A. The Owner will engage an independent testing laboratory inspect and verify the application of material in accordance with the provisions Tnemec Company.
  - 1. Material inspection and testing shall be performed 24 hours after completion of final application coat.
  - 2. The results of the above tests shall be made available to all parties at the completion of each pre-designated area and approval.
  - 3. In-place material not in compliance with the specified thickness requirements shall be corrected prior to final acceptance.
- B. The dry film thickness (DFT) of the applied material shall be measured with a non-destructive coating thickness gage after material has completely cured. All measurements shall be documented in writing and furnished to the Owner.
- C. Manufacturer's Technical Services: Coordinate with coating manufacturer's technical service department or independent sales representative for current technical data and instructions.

### **3.6 CLEANING AND PROTECTION**

- A. Remove overspray materials from surfaces not required to be thermally protected.
- B. Protect surfaces of coating systems from damage during construction.
- C. Touch-up, or repair damaged products before Substantial Completion.

### **3.7 ONE-YEAR INSPECTION**

- A. Owner will set date for one-year inspection of coating systems.
- B. Inspection shall be attended by Owner, Contractor, Architect, and manufacturer's representative.
- C. Repair deficiencies in coating systems as determined by Architect in accordance with manufacturer's instructions.

### **3.8 FLUID APPLIED INSULATION COATING SCHEDULE**

- A. Ferrous Steel Wide Flange, Mio-Zinc MCU Primer:
  - 1. Surface Preparation: Minimum SSPC-SP3 Power Tool Cleaning
  - 2. Prime Coat (Shop or Field): Series 394-0250 PerimePrime, DFT of 2.5 to 3.5 mils DFT
  - 3. Finish Coat (Shop or Field): Two Coats: Series 971 Aerolon Acrylic, DFT of 40.0 to 50.0 mils per coat. Total thickness of Series 971: 80 to 100 mils.
- B. Ferrous Steel Tube Steel, Mio-Zinc MCU Primer:
  - 1. Surface Preparation: Minimum SSPC-SP3 Power Tool Cleaning
  - 2. Prime Coat (Shop or Field): Series 394-0250 PerimePrime, DFT of 2.5 to 3.5 mils DFT
  - 3. Finish Coat (Shop or Field): Series 971 Aerolon Acrylic, Total thickness of Series 971: 120-125 mils DFT.

- C. Galvanized Angle Steel, Water based Epoxy Primer:
  - 1. Surface Preparation: Abrasive blast in accordance with ASTM D 6386 Surface Preparation of Hot Dipped Galvanized Surfaces Prior to Painting
  - 2. Prime Coat (Shop or Field): Series 1224 Epoxoline WB, DFT of 4.0 to 6.0 mils DFT
  - 3. Finish Coat (Shop or Field): Two Coats: Series 971 Aerolon Acrylic, DFT of 40.0 to 50.0 mils per coat. Total thickness of Series 971: 80 to 100 mils.
- D. Interior Steel Exposed to View: Provide finish coat of Series 1028 Enduratone at 2.0 – 3.0 mils DFT.

### **3.9 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.
  - 2. Solvent-based paints.
- D. Do not dispose of paints or solvents by pouring on ground. Place in designated containers for proper disposal.
- E. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 07 21 63**

## **SECTION 07 27 26 - FLUID-APPLIED MEMBRANE AIR BARRIERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Vapor-permeable, fluid-applied air barriers.
- B. Related Requirements:
  - 1. Division 03 Section "Cast in Place Concrete"
  - 2. Division 06 Section "Sheathing" for wall sheathings and wall sheathing joint-and-penetration treatments.
  - 3. Division 07 Section "Self-Adhering Sheet Waterproofing"
  - 4. Division 07 Section "PVC Roofing"
  - 5. Division 07 Section "Sheet Metal Flashing & Trim"
  - 6. Division 07 Section "Joint Sealants"
  - 7. Division 08 Section "Glazed Aluminum Curtain Wall" for extruded silicone air and vapor barrier transitions to be used at exterior wall openings.

#### **1.3 DEFINITIONS**

- A. Air-Barrier Assembly: The collection of air-barrier materials and accessories applied to an opaque wall, including joints and junctions to abutting construction, to control air movement through the wall.

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. General: Air barrier shall be capable of performing as a continuous vapor-permeable air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air barrier assemblies shall be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.
- B. The building envelope shall be designed and constructed with a continuous air barrier to control air leakage into, or out of the conditioned space.
  - 1. It must be continuous, with all joints made airtight.
  - 2. It shall have an air permeability not to exceed 0.004 cfm/sq. ft. under a pressure differential of 0.3 in. water (1.57 psf) (equal to 0.02 L/s. x sq. m. @ 75 Pa), when tested in accordance with ASTM E2178.
  - 3. It shall have an air permeability not to exceed 0.04 cfm/sq. ft. under a pressure differential of 0.3 in. water (1.57 psf) (equal to 0.2 L/s. x sq. m. @ 75 Pa), when tested in accordance with ASTM E2357.
  - 4. It shall be capable of withstanding positive and negative combined design wind, fan and stack pressures on the envelope without damage or displacement and shall transfer the load to the structure. It shall not displace adjacent materials under full load.
  - 5. It shall be durable or maintainable.
  - 6. The air barrier shall be joined in an airtight and flexible manner to the air barrier material of adjacent systems, allowing for the relative movement of systems due to thermal and moisture variations and creep. Connection shall be made between:
    - a. Foundation and walls

- b. Walls and windows or doors
  - c. Different wall systems
  - d. Wall and roof
  - e. Wall and roof over unconditioned space
  - f. Walls, floor and roof across construction, control and expansion joints
  - g. Walls, floors and roof to utility, pipe and duct penetrations
7. All penetrations of the air barrier and paths of air infiltration/exfiltration shall be made airtight.

## 1.5 REFERENCES

- A. The following standards and publications are applicable to the extent referenced in the text. The most recent version of these standards is implied unless otherwise stated.
- B. American Society for Testing and Materials (ASTM)
- 1. ASTM C1193 Guide for Use of Joint Sealants
  - 2. ASTM D412 Standard Test Methods for Rubber Properties in Tension
  - 3. ASTM D570 Test Method for Water Absorption of Plastics
  - 4. ASTM D1004 Test Method for Initial Tear Resistance of Plastic Film and Sheeting
  - 5. ASTM D1876 Test Method for Peel Resistance of Adhesives
  - 6. ASTM D1938 Test Method for Tear Propagation Resistance of Plastic Film and Sheeting
  - 7. ASTM D1970 Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
  - 8. ASTM D4258 Practice for Surface Cleaning Concrete for Coating
  - 9. ASTM D4263 Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
  - 10. ASTM D4541 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
  - 11. ASTM E96 Test Methods for Water Vapor Transmission of Materials
  - 12. ASTM E154 Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover
  - 13. ASTM E1186 Practice for Air Leakage Site Detection in Building Envelopes and Air Retarder Systems
  - 14. ASTM E2178 Standard Test Method for Air Permeance of Building Materials
  - 15. ASTM E2357 Standard Test Method for Determining Air Leakage of Air Barrier Assemblies
  - 16. NFPA 285 Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components

## 1.6 SUBMITTALS

- A. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate; technical data; and tested physical and performance properties of air barrier.
- B. Shop Drawings: Show locations and extent of air barrier. Include details for substrate joints and cracks, counterflashing strip, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
- 1. Include details of interfaces with other materials that form part of air barrier
- C. Samples: Submit representative samples of the following for approval:
- 1. Fluid-Applied membrane
  - 2. Self-Adhered Transition Membrane
  - 3. Self-Adhered Through Wall Flashing
- D. Letter of Verification of Compatibility:



1. Provide letter to verify compatibility of products in this section which come into contact with those listed in the following sections, as shown in the Architectural Drawings:
  - a. Division 07 Section "Fluid-Applied Membrane Air Barriers."
  - b. Division 07 Section "Fluid Applied Insulation Coating."
  - c. Division 07 Section "Pre-Applied Sheet Membrane Waterproofing."
  - d. Division 07 Section "Self-Adhering Sheet Waterproofing."
  - e. Division 07 Section "Thermal Insulation," especially spray applied.
  - f. Division 07 Section "Applied Fireproofing."
  - g. Division 07 Section "Polyvinyl-Chloride (PVC) Roof."
  - h. Division 07 Section "Sheet Metal Flashing & Trim."
  - i. Division 07 Section "Flexible Stainless Steel Flashing."
  - j. Division 08 Section "Glazed Alum Curtain Walls," especially the Extruded Silicone Air and Vapor Barrier Transitions.
2. Provide additional testing as required to verify compatibility.

E. Qualification Data: For Applicator.

F. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for air barriers, submit certified test report showing compliance with requirements specified for ASTM E2178.

G. Warranty: Submit a sample warranty identifying the terms and conditions stated in Article 1.10.

## 1.7 QUALITY ASSURANCE

A. Manufacturer: Air barrier systems shall be manufactured and marketed by a firm with a minimum of 20 years experience in the production and sales of waterproofing and air barriers. Manufacturers proposed for use, but not named in these specifications shall submit evidence of ability to meet all requirements specified, and include a list of projects of similar design and complexity completed within the past five years.

B. Source Limitations: Obtain primary air-barrier material and through wall flashing through one source from a single manufacturer. Should project require a vapor permeable and a vapor impermeable air barrier on same project, obtain vapor-permeable and vapor impermeable air barrier and through wall flashing from one source from a single manufacturer.

C. Applicator Qualifications: A firm experienced in applying air barrier materials similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.

D. Pre-Installation Conference: A pre-installation conference shall be held prior to commencement of field operations to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work. Preinstallation conference shall include the Contractor, installer, Architect, and system manufacturer's field representative. Agenda for meeting shall include but not be limited to the following:

1. Review of submittals
2. Review of surface preparation, minimum curing period and installation procedures
3. Review of special details and flashings
4. Sequence of construction, responsibilities and schedule for subsequent operations
5. Review of inspection, testing, protection and repair procedures

E. Products in this section may be included in freestanding mockups.

## 1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials and products in labeled packages. Store and handle in strict compliance with manufacturer's instructions, recommendations and material safety data sheets. Protect from

damage from sunlight, weather, excessive temperatures and construction operations. Remove damaged material from the site and dispose of in accordance with applicable regulations.

- B. Do not double-stack pallets of fluid applied membrane components on the job site. Provide cover on top and all sides, allowing for adequate ventilation.
- C. Protect fluid-applied membrane components from freezing and extreme heat.
- D. Sequence deliveries to avoid delays, but minimize on-site storage.

## **1.9 PROJECT CONDITIONS**

- A. Environmental Limitations: Apply air barrier within the range of ambient and substrate temperatures recommended by air barrier manufacturer. Protect substrates from environmental conditions that affect performance of air barrier. Do not apply air barrier to a wet substrate or during snow, rain, fog, or mist.

## **1.10 WARRANTY**

- A. Submit manufacturer's warranty that air barrier and accessories are free of defects at time of delivery and are manufactured to meet manufacturer's published physical properties and material specifications.
  - 1. Warranty Period: Five years from date of completion of the air barrier membrane installation.
- B. Installer's Warranty
  - 1. Special Installer's Warranty
  - 2. Provide Installer Warranty, signed by Installer, covering Work of this Section.
  - 3. Warranty Period: Two years from date of completion of the air barrier membrane installation.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Source Limitations: Obtain primary air-barrier materials and air-barrier accessories from single source from single manufacturer.
- B. Requirement: Provide primers, transition strips, termination strips, joint reinforcing fabric and strips, joint sealants, counterflashing strips, flashing sheets and metal termination bars, termination mastic, substrate patching materials, adhesives, tapes, foam sealants, lap sealants, and other accessory materials that are recommended in writing by air-barrier manufacturer to produce a complete air-barrier assembly and that are compatible with primary air-barrier material and adjacent construction to which they may seal.

### **2.2 FLUID-APPLIED, VAPOR PERMEABLE MEMBRANE AIR BARRIER**

- A. FLUID-APPLIED AIR BARRIER MEMBRANE: Perm-A-Barrier® VPL, as manufactured by GCP Applied Technologies, Cambridge, MA, or an approved equivalent.
  - 1. A fluid-applied, vapor permeable, acrylic membrane that cures to form a resilient, monolithic, fully bonded elastomeric membrane when applied to construction surfaces. The membrane provides superior protection against the damaging effects of air and liquid water ingress on the building structures. Product shall meet the following requirements:
  - 2. Membrane Air Permeance: ASTM E2178: Not to exceed 0.004 cfm/sq. ft. under a pressure differential of 0.3 in. water (1.57 psf) (equal to 0.02 L/s. x sq. m. @ 75 Pa)
  - 3. Assembly Air Permeance: Provide a continuous air barrier assembly that has an air leakage not to exceed 0.04 cfm/sq. ft. of surface area under a pressure differential of 0.3

- in. water (1.57 psf) (equal to 0.2 L/s. x sq. m. of surface area at 75 Pa) when tested in accordance with ASTM E2357.
4. Water Vapor Permeance: ASTM E96, Method B: Greater than 10 perms
  5. Pull Adhesion: ASTM D4541: minimum 20 psi or substrate failure to glass faced wall board, minimum 100 psi to concrete/CMU
  6. Low temperature flexibility: ASTM D1970: Pass at minus 20 degrees Fahrenheit (at minus 29 degrees Celsius).
  7. Water resistance of in-place membrane: ASTM E331: Pass. No water penetration after 90 minutes @ 299 Pa (6.24 psf) tested over OSB and gypsum sheathing.
  8. Nail sealability: ASTM D1970: Pass UV Exposure Limit: Equal to or greater than 180 calendar days
  9. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly
- B. TRANSITION MEMBRANE: Perm-A-Barrier Detail Membrane manufactured by GCP Applied Technologies, or approved equivalent.
1. A 0.9 mm (36 mils) of self-adhesive rubberized asphalt integrally bonded to 0.1 mm (4 mil) of cross-laminated, high-density polyethylene film to provide a min. 1.0 mm (40 mil) thick membrane. Membrane shall be interleaved with disposable silicone-coated release paper until installed, conforming with the following:
  2. Water Vapor Transmission: ASTM E96, Method B: 0.05 perms (2.9 ng/Pa s. sq. m.) maximum
  3. Air Permeance at 75 Pa (0.3 in. water) pressure difference: 0.0006 L/s. sq. m (0.00012 cfm/ sq. ft.) maximum
  4. Puncture Resistance: ASTM E154: 178 N (40 lbs.) minimum
  5. Lap Adhesion at minus 4 degrees Celsius (25 degrees Fahrenheit): ASTM D1876: 880 N/m (5.0 lbs./in.) of width
  6. Low Temperature Flexibility: ASTM D1970: Unaffected to minus 43 degrees Celsius (minus 45 degrees Fahrenheit)
  7. Tensile Strength: ASTM D412, Die C Modified: minimum 2.7 MPa (400 psi)
  8. Elongation, Ultimate Failure of Rubberized Asphalt: ASTM D412, Die C: minimum 200%
- C. FLEXIBLE MEMBRANE WALL FLASHING: Perm-A-Barrier Wall Flashing manufactured by GCP Applied Technologies, or an approved equivalent.
1. A 0.8 mm (32 mils) of self-adhesive rubberized asphalt integrally bonded to 0.2 mm (8 mil) of cross-laminated, high-density polyethylene film to provide a min. 1.0 mm (40 mil) thick membrane. Membrane shall be interleaved with disposable silicone-coated release paper until installed, conforming with the following:
  2. Water Vapor Transmission: ASTM E96, Method B: 0.05 perms (2.9 ng/ Pa s. sq. m.) maximum
  3. Water Absorption: ASTM D570: max. 0.1% by weight
  4. Puncture Resistance: ASTM E154: 356 N (80 lbs.) minimum
  5. Tear Resistance
    - a. Initiation ASTM D1004: min. 58 N (13.0 lbs.) M.D.
    - b. Propagation ASTM D1938: min. 40 N (9.0 lbs.) M.D.
  6. Lap Adhesion at minus 4 degrees Celsius (25 degrees Fahrenheit): ASTM D1876: 880 N/m (5.0 lbs./in.) of width
  7. Low Temperature Flexibility: ASTM D1970: Unaffected to minus 43 degrees Celsius (minus 45 degrees Fahrenheit)
  8. Tensile Strength: ASTM D412, Die C Modified: minimum 5.5 MPa (800 psi)
  9. Elongation, Ultimate Failure of Rubberized Asphalt: ASTM D412, Die C: minimum 200%

## 2.3 PRIMERS

- A. Primer for Self-Adhered Transition Membrane and Flexible Membrane Wall Flashing: Perm-A-Barrier WB Primer manufactured by GCP Applied Technologies or an approved equivalent; a water-based primer which imparts an aggressive, high tack finish on the treated substrate.
1. Flash Point: No flash to boiling point

2. VOC Content: Not to exceed 10 g/L
  3. Application Temperature: minus 4 degrees Celsius (25 degrees Fahrenheit) and above
  4. Freezing point (as packaged): minus 7 degrees Celsius (21 degrees Fahrenheit)
- B. Primer for Self-Adhered Transition Membrane and Flexible Membrane Wall Flashing:: Perm-A-Barrier Primer Plus manufactured by GCP Applied Technologies or an approved equivalent; a water-based primer which imparts an aggressive, high tack finish on the treated substrate. Product shall have the following minimum physical properties:
1. Color: Milky White (wet), Clear (dry)
  2. Weight: 8.25 lbs./gal.
  3. Solids Content (by weight): 53-57%
  4. Solvent Type: Water
  5. VOC Content: Not to excess 1 g/L
  6. Application Temperature: 4 degrees Celsius (40 degrees Fahrenheit) and above

## **2.4 PENETRATIONS & TERMINATION SEALANT**

- A. Liquid Membrane for Details and Terminations and Substrate Patching: Bituthene Liquid Membrane manufactured by GCP Applied Technologies or an approved equivalent; a two-part, elastomeric, trowel grade material designed for use with fluid-applied membranes, self-adhered membranes and tapes. 10 g/L maximum VOC content.
- B. Sealant for Details, Final Terminations and Sheathing Joint Treatment: S100 Sealant manufactured by GCP Applied Technologies or an approved equivalent: a one-part, neutral curing, ultra low modulus material designed for use with fluid-applied membranes, self-adhered membrane and tapes. 98 g/L maximum VOC content.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that substrates and conditions are ready to accept the Work of this section. Submit documentation of any discrepancies in writing. Commencement of the Work or any parts thereof shall mean acceptance of the prepared substrates.
- B. All surfaces must be sound, dry, clean and free of oil, grease, dirt, excess mortar or other contaminants detrimental to the adhesion of the membranes. Fill voids, gaps and spalled areas in substrate to provide an even plane. Strike masonry joints full-flush.
1. Curing compounds or release agents used in concrete construction must be resin based without oil, wax or pigments.

### **3.2 SURFACE PREPARATION**

- A. Refer to manufacturer's literature for requirements for preparation of substrates. Surfaces shall be sound and free of voids, spalled areas, loose aggregate and sharp protrusions. Remove contaminants such as grease, oil and wax from exposed surfaces. Remove dust, dirt, loose stone and debris. Use repair materials and methods that are acceptable to manufacturer of the fluid-applied air barrier assembly.
- B. Exterior sheathing panels: Ensure that the boards are sufficiently stabilized with corners and edges fastened with appropriate screws. Pre-treat all board joints with 50 – 75 mm (2-3 in.) wide, manufacturer's recommended mesh-style wallboard tape. Gaps greater than 6 mm (1/4 in.) should be filled with mastic or caulk, allowing sufficient time to fully cure before application of the mesh-style wallboard tape and fluid applied air barrier system.
- C. Concrete and Other Monolithic Cementitious Surfaces: Surface irregularities greater than 1/4 in. across and/or 1/8 in. in depth should be pre-treated with waterproofing liquid membrane or repaired with a lean mortar mix or nonshrinking grout. Remove concrete form lines and any high

spots greater than 1/8 in. (3 mm) in height to ensure uniform surface. On highly dusty or porous substrates it may be necessary to apply a scratch coat of air barrier liquid membrane prior to spraying to full thickness.

1. Air barrier membrane may be applied to green (minimum 3 day cure time) concrete or over damp to-touch surfaces. Remove any visible water prior to application.
- D. Masonry Substrates: Apply air and vapor barrier over concrete block and brick with smooth trowel-cut mortar joints, struck full and flush. Fill all voids and holes, particularly in the mortar joints, with a lean mortar mix, non-shrinking grout or parge coat.
  - E. Related Materials: Treat construction joints and install flashing as recommended by manufacturer.
  - F. Clean, prepare, treat, and seal substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air barrier application.
  - G. Mask off adjoining surfaces not covered by air barrier to prevent spillage and overspray affecting other construction.
  - H. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete.
  - I. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids in concrete with substrate patching membrane.
  - J. Remove excess mortar from masonry ties, shelf angles, and other obstructions.
  - K. At changes in substrate plane, apply sealant or Bituthene Liquid Membrane at sharp corners and edges to form a smooth transition from one plane to another.
  - L. Cover gaps in substrate plane and form a smooth transition from one substrate plane to another with stainless-steel sheet mechanically fastened to structural framing to provide continuous support for air barrier.

### **3.3 JOINT TREATMENT**

- A. Concrete and Masonry: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C1193 and air barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D4258 before coating surfaces.
  1. Prime substrate as required.
- B. Gypsum Sheathing: Fill joints with S100 Sealant per manufacturer's written instructions.

### **3.4 AIR BARRIER MEMBRANE INSTALLATION**

- A. Apply air barrier membrane to achieve a continuous air barrier according to air barrier manufacturer's written instructions.
- B. Apply air barrier membrane within manufacturer's recommended application temperature ranges.
- C. Apply a continuous unbroken air barrier to substrates according to the following minimum thickness. Apply membrane in full contact around protrusions such as masonry ties.
  1. Vapor-Permeable Membrane Air Barrier: 70-mil (1.8-mm) wet film thickness, 40-mil (1.0-mm) dry film thickness.
- D. Do not cover air barrier until it has been tested and inspected by Owner's testing agency.

- E. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air barrier components.

### **3.5 TRANSITION MEMBRANE INSTALLATION**

- A. Install strips, transition membrane, and auxiliary materials according to air barrier manufacturer's written instructions to form a seal with adjacent construction and maintain a continuous air barrier.
- B. Apply primer to substrates to receive transition membrane at required rate and allow to dry. Limit priming to areas that will be covered by transition tape in same day. Re-prime areas exposed for more than 24 hours.
  - 1. Prime glass-fiber-surfaced gypsum sheathing not covered with air membrane material with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- C. Connect and seal exterior wall air barrier membrane continuously to roofing membrane air barrier, concrete below-grade structures, floor-to floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
- D. At end of each working day, seal top edge of strips and transition membrane to substrate with termination sealant.
- E. Apply joint sealants forming part of air barrier assembly within sealant manufacturer's recommended application temperature ranges. Consult sealant manufacturer when sealant cannot be applied within these temperature ranges.
- F. Wall Openings: Prime concealed perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition membrane so that a minimum of 3 inches (75 mm) of coverage is achieved over both substrates.
  - 1. Transition Membrane: Roll firmly to enhance adhesion.
- G. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, and doors, and miscellaneous penetrations of air barrier membrane with foam sealant.
- H. Repair punctures, voids, and deficient lapped seams in strips and transition membrane. Slit and flatten fish-mouths and blisters. Patch with transition membrane extending 6 inches (150 mm) beyond repaired areas in strip direction.

### **3.6 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner may engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Inspections: Air barrier materials and installation are subject to inspection for compliance with requirements. Inspections may include the following:
  - 1. Continuity of air barrier system has been achieved throughout the building envelope with no gaps or holes
  - 2. Continuous structural support of air barrier system has been provided
  - 3. Masonry and concrete surfaces are smooth, clean and free of cavities, protrusions, and mortar droppings
  - 4. Site conditions for application temperature and dryness of substrates have been maintained
  - 5. Maximum exposure time of materials to UV deterioration has not been exceeded
  - 6. Surfaces have been primed, if applicable

7. Laps in strips and transition membrane have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fish-mouths
  8. Termination sealant has been applied on cut edges
  9. Strips and transition membrane have been firmly adhered to substrate
  10. Compatible materials have been used
  11. Transitions at changes in direction and structural support at gaps have been provided.
  12. Connections between assemblies (membrane and sealants) have complied with requirements for cleanliness, preparation and priming of surfaces, structural support, integrity, and continuity of seal
  13. All penetrations have been sealed
- C. Air Barrier Thickness Tests:
1. Perform a thickness test of the Air Barrier material every 1000 square feet of installation as the work progresses.
  2. Remove and replace deficient air barrier components and retest as specified above.
- D. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.

### **3.7 CLEANING AND PROTECTION**

- A. Protect air barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
- B. Protect air barrier from exposure to UV light and harmful weather exposure as required by manufacturer. Remove and replace main air barrier material exposed for more than 180 days.
- C. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended by manufacturer of affected construction.
- D. Remove masking materials after installation.

### **3.8 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
1. Aluminum
  2. Plastic Materials and Gaskets
  3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
1. Treated, stained, painted or contaminated wood.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling

**END OF SECTION 07 27 26**

## **SECTION 07 42 13 – FORMED METAL WALL PANELS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Concealed fastener metal wall panels.
- B. Related Requirements:
  - 1. Division 05 Section "Cold Formed Metal Framing."
  - 2. Division 06 Section "Sheathing."
  - 3. Division 07 Section "Insulation."
  - 4. Division 07 Section "Air Barriers."
  - 5. Division 07 Section "Rainscreen Attachment System."
  - 6. Division 07 Section "Sheet Metal Flashing & Trim."
  - 7. Division 07 Section "Joint Sealants."

#### **1.3 QUALITY ASSURANCE**

- A. Manufacturer/Source: Provide metal wall panel and panel accessories from a single manufacturer.
- B. Manufacturer Qualifications: Minimum 10 years experience in manufacture of similar products in successful use in similar applications.
- C. Wall Systems Installer Qualifications: Experienced Installer with minimum of 5 years experience with successfully completed projects of a similar nature and scope.

#### **1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Preinstallation Meeting: Conduct preinstallation meeting at site attended by Owner, Architect, manufacturer's representative, and other trade contractors.
  - 1. Coordinate building framing in relation to metal wall panel assembly.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: Manufacturer's data sheets, for specified products.
  - 1. Include data indicating compliance with performance requirements.
- B. Shop Drawings: Provide shop drawings prepared by manufacturer or manufacturer's authorized Installer. Include full elevations showing openings and penetrations. Include details of each condition of installation and attachment. Provide details at a minimum scale of 1-1/2-inch per foot (1:8) of all required trim and extrusions needed for a complete installation.
  - 1. Indicate points of supporting structure that must coordinate with metal wall panel assembly installation.
  - 2. Indicate details of fastening, including clip spacing, supported by load span tables that include an evaluation of clip and panel side joint interaction.
- C. Samples for Initial Selection: For each product specified. Provide representative color charts of manufacturer's full range of colors.



- D. Samples for Verification: Provide 12-inch section of panel(s) showing finishes. Provide 12-inch long pieces of trim pieces and other exposed components.

## **1.6 INFORMATIONAL SUBMITTALS**

- A. Product Test Reports: Indicating compliance of products with requirements, from a qualified independent testing agency.
- B. Qualification Information: For Installer firm.
- C. Manufacturer's warranty: Submit sample warranty.

## **1.7 CLOSEOUT SUBMITTALS**

- A. Maintenance data.

## **1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Protect metal wall panel products during shipping, handling, and storage to prevent staining, denting, deterioration of components or other damage.
  - 1. Deliver, unload, store, and erect metal wall panel products and accessory items without misshaping panels or exposing panels to surface damage from weather or construction operations.

## **1.9 WARRANTY**

- A. Special Manufacturer's Warranty: On manufacturer's standard form, in which manufacturer agrees to repair or replace components of metal wall panel assemblies that fail in materials and workmanship within two years from date of Substantial Completion.
- B. Special Panel Finish Warranty: On manufacturer's standard form, in which manufacturer agrees to repair or replace metal wall panels that display evidence of deterioration of finish within 20 years from the date of substantial completion.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. General: Provide metal wall panel assemblies meeting performance requirements as determined by application of specified tests by a qualified testing agency on manufacturer's standard assemblies.
- B. Air Infiltration: When installed over Insulated Composite Backup Panels or Metal Liner Panels, maximum 0.06 cfm/sq. ft. (0.3 L/s per sq. m) per ASTM E 283 at a static-air-pressure difference of 1.57 lbf/sq. ft. (75 Pa), using minimum 10-by-10 foot (3050-by-3050 mm) test panel that includes side joints.
- C. Water Penetration, Static Pressure: When installed over Insulated Composite Backup Panels or Metal Liner Panels, no uncontrolled water penetration per ASTM E 331 at a minimum static differential pressure of 6.24 lbf/sq. ft. (299 Pa), using minimum 10-by-10 foot (3050-by-3050 mm) test panel that includes side joints.
- D. Thermal Movements: Allow for thermal movements from variations in both ambient and internal temperatures. Accommodate movement of support structure caused by thermal expansion and contraction.

## 2.2 SYSTEM DESCRIPTION

- A. **Metal Wall Panels over Outside-Insulated Framed Wall System:** Single-skin concealed fastener metal wall panels applied as exterior rainscreen cladding over wall framing specified in Division 05 Section "Cold-Formed Metal Framing" with exterior sheathing specified in Division 06 Section "Sheathing", an applied membrane that provides air, moisture, and water vapor control specified in Division 07 Section "Air Barriers", and insulation within the framing and applied outboard of the sheathing specified in Division 07 Section "Thermal Insulation". Metal wall panel installation specified in this Section includes secondary metal subgirt framing and mounting clips for panel attachment.
1. Air, moisture, and water vapor control membrane is provided under Division 07 Section "Weather Barriers."

## 2.3 MANUFACTURERS

- A. Basis of Design: **Concept Series Metal Wall Panels by CENTRIA Architectural Systems.** Provide basis of design product or approved equivalent.

## 2.4 PANEL MATERIALS

- A. Metallic-Coated Steel Face Sheet: Coil-coated, ASTM A 755/A 755M.
1. Aluminum-zinc alloy-coated (Galvalume) Steel Sheet: ASTM A 792/A 792M, Class AZ50 Grade 50 (Class AZM150, Grade 275), structural steel quality.
  2. Face Sheet: Minimum 0.036 inch/20 gage (0.91 mm) nominal uncoated thickness.
  3. Surface: Smooth.

## 2.5 CONCEALED FASTENER METAL WALL PANELS

- A. Metal Wall Panels, General: Factory-formed, concealed fastener panels with interconnecting side joints, fastened to supports with concealed fasteners, with factory-applied sealant in side laps when required to meet performance requirements.
- B. Four-rib profile with recessed flat pan between ribs and concealed extended fastener leg:
1. Basis of Design Product: **CENTRIA, CS-660E**, or approved equivalent.
  2. Panel Coverage: 16 inches (406 mm).
  3. Panel Height: 0.875 inch (22 mm).
- C. Exposed Coil-Coated Finish System:
1. Fluoropolymer Three-Coat System: 0.8 mil primer with 0.8 mil 70 percent PVDF fluoropolymer color coat, and a 0.8 mil 70 percent PVDF fluoropolymer clear coat, AAMA 621.
    - a. Basis of Design: CENTRIA Duragard Plus or approved equivalent.
    - b. One color required.

## 2.6 ATTACHMENT SYSTEM

- A. See Division 07 Section "Rainscreen Attachment System".

## 2.7 METAL WALL PANEL ACCESSORIES

- A. Metal Wall Panel Accessories, General: Provide complete metal wall panel assembly incorporating trim, copings, fasciae, parapet caps, soffits, sills, inside and outside corners, and miscellaneous flashings. Provide manufacturer's factory-formed clips, shims, flashings, lap tapes, and closure strips for a complete installation. Fabricate and install accessories in accordance with SMACNA Manual.

- B. Mitered Corners: Structurally-bonded horizontal interior and exterior trimless corners matching metal wall panel material, profile, and factory-applied finish, fabricated and finished by metal wall panel manufacturer.
  - 1. Welded, riveted, fastened, or field- fabricated corners do not meet the requirements of this specification.
  - 2. Basis of Design: **CENTRIA, MicroSeam Corners** or approved equivalent.
- C. Formed Flashing and Trim: Match material, thickness, and color of metal wall panel face sheets.
- D. Sealants: Type recommended by metal wall panel manufacturer for application, meeting requirements of Division 07 Section "Joint Sealants."
- E. Flashing Tape: 4-inch wide self-adhering butyl flashing tape.
- F. Fasteners, General: Self-tapping screws, bolts, nuts, and other acceptable fasteners recommended by panel manufacturer. Where exposed fasteners cannot be avoided for miscellaneous applications, supply corrosion-resistant fasteners with heads matching color of metal wall panels by means factory-applied coating.
- G. Concealed Clips: Galvanized steel, 0.06 inch/16 ga. (1.52 mm) nominal thickness, designed to allow unimpeded thermal movement of panel and configured to hold panel minimum 1/2 inch (12.7 mm) from substrate.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine metal wall panel substrate with Installer present. Inspect for erection tolerances and other conditions that would adversely affect installation of metal wall panels.
- B. Wall Substrate: Confirm that wall substrate is within tolerances acceptable to metal wall panel system manufacturer.
  - 1. Maximum deviations acceptable:
    - a. 1/4-inch in 20 feet (6.4 mm in 6 m) vertically or horizontally from face plane of framing.
    - b. 1/2-inch (12.7 mm) across building elevation.
    - c. 1/8-inch in 5 feet (3.2 mm in 1.5 m).
- C. **Framing:** Inspect framing that will support metal wall panels to determine if support components are installed as indicated on approved shop drawings. Confirm presence of acceptable framing members at recommended spacing to match installation requirements of metal wall panels.
- D. Advise G.C., in writing, of out-of-tolerance work and other deficient conditions prior to proceeding with metal wall panel system installation.
- E. Correct out of tolerance work and other deficient conditions prior to proceeding with insulated composite backup panel installation.

### **3.2 METAL WALL PANEL INSTALLATION**

- A. General: Install metal wall panels in accordance with approved shop drawings and manufacturer's recommendations. Install metal wall panels in orientation, sizes, and locations indicated. Anchor metal wall panels and other components securely in place. Provide for thermal and structural movement

- B. Attach panels to metal framing using recommended clips, screws, fasteners, sealants, and adhesives indicated on approved shop drawings.
  - 1. Fasteners for Steel Wall Panels: Stainless-steel for exterior locations and locations exposed to moisture; carbon steel for interior use only.
  - 2. Fasten metal wall panels to supports with concealed clips at each joint at location, spacing, and with fasteners recommended by manufacturer. Install clips to supports with self-tapping fasteners.
  - 3. Dissimilar Materials: Where elements of metal wall panel system will come into contact with dissimilar materials, treat faces and edges in contact with dissimilar materials as recommended by manufacturer.
- C. Joint Sealers: Install joint sealants where indicated on approved shop drawings.

### **3.3 ACCESSORY INSTALLATION**

- A. General: Install metal wall panel accessories with positive anchorage to building and provide for thermal expansion. Coordinate installation with flashings and other components.
  - 1. Install related flashings and sheet metal trim per requirements of Division 07 Section "Sheet Metal Flashing and Trim."
  - 2. Install components required for a complete metal wall panel assembly, including trim, copings, corners, lap strips, flashings, sealants, fillers, closure strips, and similar items.
  - 3. Comply with performance requirements and manufacturer's written installation instructions.
  - 4. Provide concealed fasteners except where noted on approved shop drawings.
  - 5. Set units true to line and level as indicated.

### **3.4 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 05 50 00**

## **07 42 15 – METAL COMPOSITE WALL & SOFFIT PANELS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes aluminum faced composite panels, for both walls and soffit applications, with mounting system.
  - 1. Panel mounting system including anchorages, shims, furring, fasteners, gaskets and sealants, related flashing adapters, and masking (as required) for a complete installation.
- B. Related Requirements:
  - 1. Division 05 Section "Cold Formed Metal Framing."
  - 2. Division 06 Section "Sheathing."
  - 3. Division 07 Section "Insulation."
  - 4. Division 07 Section "Air Barriers."
  - 5. Division 07 Section "Rainscreen Attachment System."
  - 6. Division 07 Section "Sheet Metal Flashing & Trim."
  - 7. Division 07 Section "Joint Sealants."

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: Include fabrication and installation layouts of metal composite material panels and thermally broken exterior attachment/support framing system; details of edge conditions, joints, panel profiles, corners, anchorages, attachment assembly, trim, flashings, closures, and accessories; and special details.
- C. Samples: For each type of metal composite material panel indicated.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Product test reports.
- B. Warranties: Samples of special warranties.

#### **1.6 CLOSEOUT SUBMITTALS**

- A. Maintenance data.

#### **1.7 QUALITY ASSURANCE**

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

- B. Maximum deviation from vertical and horizontal alignment of erected panels: 6mm (1/4") in 6m (20') non-accumulative.
- C. Panel fabricator/installer shall assume undivided responsibility for all components of the exterior panel system including, but not limited to attachment to sub-construction, panel to panel joinery, panel to dissimilar material joinery, and joint seal associated with the panel system.
- D. Field measurements should be taken prior to the completion of shop fabrication whenever possible. However, coordinate fabrication schedule with construction progress as directed by the Contractor to avoid delay of work. Field fabrication may be allowed to ensure proper fit. However, field fabrication shall be kept to an absolute minimum with the majority of the fabrication being done under controlled shop conditions.

## **1.8 MOCKUP**

- A. 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 mockup of typical metal composite material panel assembly including **corner**, soffit, supports, attachments, and accessories.
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
  - 4. Products in this section may be required in a freestanding mockup.

## **1.9 DELIVERY, STORAGE AND HANDLING**

- A. Protect finish and edges in accordance with panel manufacturer's recommendations.
- B. Store material in accordance with panel manufacturer's recommendations.

## **1.10 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal composite material panel systems that fail in materials or workmanship within specified warranty period.
  - 1. 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 composite material panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Finish Warranty Period: 20 years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Structural Performance: Provide metal composite material panel systems capable of withstanding the effects of the following loads, based on testing according to ASTM E 330:
  - 1. Wind Loads: As indicated on Drawings.
  - 2. Other Design Loads: As indicated on Drawings.
  - 3. Deflection Limits: For wind loads, no greater than 1/180 of the span.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces
- C. Bond Integrity
1. When tested for bond integrity, in accordance with ASTM D1781 (simulating resistance to panel delamination), there shall be no adhesive failure of the bond a) between the core and the skin nor b) cohesive failure of the core itself below the following values:
    - a. Peel Strength: 115 N mm/mm (22.5 in lb/in) as manufactured; 115 N mm/mm (22.5 in lb/in) after 21 days soaking in water at 70°F
- D. Fire-Resistance Ratings: Comply with ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
- E. Fire Propagation Characteristics: Metal composite material wall panel system passes NFPA 285 testing.

## 2.2 METAL COMPOSITE MATERIAL WALL PANELS

- A. Metal Composite Material Wall Panel Systems: Provide factory-formed and -assembled, metal composite material wall panels fabricated from two metal facings that are bonded to a solid, extruded thermoplastic core; formed into profile for installation method indicated. Include attachment assemblies components, panel stiffeners and accessories required for weathertight system.
1. Basis of Design: ALUCOBOND Plus material manufactured by 3A Composites USA, Inc. or approved equivalent.
- B. Aluminum Face Sheets:
1. Thickness: 0.20mm (0.0197") (nominal)
  2. Alloy: AA3000 Series (Painted material)
- C. Aluminum-Faced Composite Wall Panels: Formed with 4 mm thick, coil-coated aluminum sheet facings.
1. Panel Thickness: 0.157 inch (4 mm).
  2. Core: Fire retardant.
- D. Exterior Finish: 3 Coat coil coated KYNAR® 500 or HYLAR® 5000 based Polyvinylidene Fluoride (PVDF) or Fluoro Ethylene – Alkyl Vinyl Ether (FEVE) resin, or approved equivalent, in conformance with the following general requirements of AAMA 2605.
- a. Color: metallic finish, match Architect's samples.
- E. System Type: Rout and Return Dry:
1. Provide Bamco D-500 Rout and Return Dry Joint, or approved equivalent.
  2. System utilizes an extruded horizontal and vertical tongue and groove extrusion system. Reveal joint is open dry joint rain screen principle. Perimeter extrusions reinforce and encapsulate panel returns, eliminating any exposed cut edges and exposed fasteners.
  3. No field sealant required in joints unless specifically noted on drawings.
- F. System must not generally have any visible fasteners, telegraphing or fastening on the panel faces or any other compromise of a neat and flat appearance.
1. Panel Bow: Maximum 0.8% of any 1828mm (72") panel dimension.
  2. Panel Dimensions: Field fabrication shall be allowed where necessary, but shall be kept to an absolute minimum. All fabrication shall be done under controlled shop conditions when possible.
  3. Panel lines, breaks, and angles shall be sharp, true, and surfaces free from warp and buckle.
  4. Maximum deviation from panel flatness shall be 1/8" in 5'0" on panel in any direction for assembled units. (Non-accumulative - No Oil Canning)

## **2.3 ATTACHMENT SYSTEM**

- A. See Division 07 Section "Rainscreen Attachment System."

## **2.4 MISCELLANEOUS MATERIALS**

- A. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal composite material panels unless otherwise indicated.
- B. Flashing and Trim: Provide flashing and trim formed from same material as metal composite material panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, bases, drips, sills, jambs, corners, endwalls, framed openings, rakes, fasciae, parapet caps, soffits, reveals, and fillers. Finish flashing and trim with same finish system as adjacent metal composite material panels.
- C. Panel Fasteners: Self-tapping screws designed to withstand design loads. Exposed fasteners in the panel returns are to be provided with heads matching color of metal composite material panels by means of factory-applied coating. Provide EPDM or PVC sealing washers for exposed fasteners. There are to be no exposed fasteners on the face of the panels.
- D. Panel Sealants: ASTM C 920; as recommended in writing by metal composite material panel manufacturer. Provide sealant types recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.

## **2.5 FABRICATION**

- A. General: Fabricate and finish metal composite material panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated.

## **2.6 FINISHES**

- A. Panels and Accessories:
  - 1. Three-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - a. Provide TWO (2) metallic finishes to match Architect's sample.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal composite material panel manufacturer's written recommendations.

### **3.2 METAL COMPOSITE MATERIAL PANEL INSTALLATION**

- A. Erect panels plumb, level, and true.



- B. Attachment system shall allow for the free and noiseless vertical and horizontal thermal movement due to expansion and contraction for a material temperature range of -20°F to +180°F. Buckling of panels, opening of joints, undue stress on fasteners, failure of sealants or any other detrimental effects due to thermal movement will not be permitted. Fabrication, assembly, and erection procedure shall account for the ambient temperature at the time of the respective operation.
- C. Panels shall be erected in accordance with an approved set of shop drawings.
- D. Anchor panels securely per engineering recommendations and in accordance with approved shop drawings to allow for necessary thermal movement and structural support.
  - 1. Where removable panels are required to access work behind panels, install such that panels can be removed and reinstalled without damaging panels or adjacent work, are held securely in place, and can be removed safely without risk to those removing panels.
- E. Conform to panel fabricator's instructions for installation of concealed fasteners.
- F. Do not install component parts that are observed to be defective, including warped, bowed, dented, abraded, and broken members.
- G. Do not cut, trim, weld, or braze component parts during erection in a manner which would damage the finish, decrease strength, or result in visual imperfection or a failure in performance. Return component parts which require alteration to shop for refabrication, if possible, or for replacement with new parts.
- H. Separate dissimilar metals and use gasketed fasteners where needed to eliminate the possibility of corrosive or electrolytic action between metals.

### **3.3 ADJUSTING AND CLEANING**

- A. Remove and replace panels damaged beyond repair as a direct result of the panel installation. After installation, panel repair and replacement shall become the responsibility of the General Contractor. Repair panels with minor damage.
- B. Remove masking (if used) as soon as possible after installation. Masking intentionally left in place after panel installation on an elevation, shall become the responsibility of the General Contractor.
- C. Any additional protection, after installation, shall be the responsibility of the General Contractor.
- D. Make sure weep holes and drainage channels are unobstructed and free of dirt and sealants.
  - 1. Final cleaning shall not be part of the work of this section.

### **3.4 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 07 42 15**

## **SECTION 07 48 00 - RAINSCREEN ATTACHMENT SYSTEM**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Provide a thermally broken, rainscreen attachment system for attachment of the following exterior building finishes installed over continuous exterior insulation:
  - 1. Stone Cladding.
  - 2. Formed Metal Wall Panels.
  - 3. Metal Composite Wall & Soffit Panels.
- B. Related Requirements:
  - 1. Division 01 Section "Quality Requirements" for Delegated Design.
  - 2. Division 05 Section "Structural Steel Framing" for steel supporting stone cladding.
  - 3. Division 05 Section "Cold-Formed Metal Framing" for steel stud frames supporting stone cladding.
  - 4. Division 07 Section "Fluid- Applied Membrane and Air and Vapor Barriers" for air and water management system behind the exterior stone cladding.
  - 5. Division 07 Section "Sheet Metal Flashing and Trim" for water management system behind the exterior stone cladding.
  - 6. Division 07 Section "Joint Sealants" for sealing joints in stone cladding system with elastomeric sealants.

#### **1.3 SYSTEM DESCRIPTION**

- A. System assembly shall include the following components from the substrate out:
  - 1. Substrate: Cold formed metal framing system and sheathing.
  - 2. Weather Resistant Barrier over substrate.
  - 3. Continuous insulation.
  - 4. Thermally broken rainscreen attachment system.
  - 5. Exterior cladding.
- B. Design Requirements:
  - 1. Manufacturer is responsible for designing system, including anchorage to structural system and necessary modifications to meet specified requirements and maintain visual design concepts.
  - 2. Employ registered professional engineer, licensed to practice engineering in jurisdiction where Project is located, to engineer each component of rainscreen attachment system.
  - 3. Structural Design: Exterior-insulated rainscreen wall assembly capable of withstanding effects of load and stresses from dead loads, wind loads, ice loads (if applicable) as indicated on Structural General Notes on Structural Drawings, and normal thermal movement without evidence of permanent defects of assemblies or components.
    - a. Thermal Movements: Provide assemblies that allow for thermal movements resulting from the following maximum ambient temperatures by preventing overstressing of components and other detrimental effects:
      - 1) Temperature Change (range): 120 degrees Fahrenheit (67 degrees C), ambient:
  - 4. Support Framing/Attachment System:
    - a. No framing component may penetrate the layer of continuous exterior insulation other than thermally isolated fasteners.

- b. Frequency and spacing of stiffened horizontal girts as indicated by manufacture in project specific engineering package.
- C. Performance Requirements:
  - 1. Rainscreen Attachment System Performance: Comply with ANSI/ASHRAE 90.1-2010 definition of continuous insulation (c.i.).
  - 2. No thermal bridges other than fasteners and service openings.
  - 3. Thermal Performance:
    - a. Continuous framing profiles (including C- or Z-shaped sections or furring) penetrating insulation not allowed.
  - 4. Framing Members:
    - a. Test framing components to AAMA TIR- A8-[04] – Section 7.2 to determine structural performance and effective moment of inertia for each perforated component. Minimum Effective Moment of Inertia: 0.0150 in<sup>4</sup>.
    - b. Localized bending stress for eccentrically loaded framing members must be evaluated with the maximum effective length of resisting element not more than 12 inches.
  - 5. Fasteners:
    - a. Minimum Safety Factor of 3 for both tension and shear values.
    - b. Combined tension and shear shall be evaluated according to an interaction formula. Sum of terms shall not exceed 1.0.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference on stone cladding and metal panel exterior finishes at project site.
  - 1. Review procedures for stone and metal panel installation, anchorage requirements/locations, and coordination with the rainscreen attachment system.
  - 2. Review schedule. Material procurement and availability.

#### 1.5 SUBMITTALS

- A. Product Data: Submit manufacturer's product literature and descriptions of testing performed on system components to indicate meeting or exceeding specified performance.
- B. Shop Drawings:
  - 1. Submit connection details to the cladding installer/engineer, showing interface of rainscreen attachment system to substrate and panels with adjacent construction, signed and sealed by Professional Engineer.
  - 2. Show system installation and attachment, including fastener size and spacing.
- C. Structural Calculations:
  - 1. Submit rainscreen attachment manufacturer's comprehensive Structural Design analysis signed and sealed by a Professional Engineer.
- D. Samples: Submit following material samples for verification:
  - 1. Horizontal Vented Stiffened Girts: Two (2) 12-inch long samples.
- E. Test Reports:
  - 1. Test to the following standards and provide written test reports by a third party:
    - a. AAMA TIR-A8-[04]: Structural Performance of Composite Thermal Barrier Framing Systems – Section 7.2.
  - 2. Comprehensive three-dimensional thermal modeling report indicating framing systems impact on exterior insulation rated R-value.

#### 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications:

1. Minimum 5 years' experience specializing in the manufacturing of façade attachment/support framing similar to those specified.
  2. Ability to demonstrate conformance to testing requirements.
- B. Installer Qualifications:
1. Minimum of 3 years' documented experience or minimum of 5 completed projects of equivalent scope and quality and recommended by manufacturer to perform work of this Section.
  2. Onsite superintendent or foreman overseeing installation on site during entire work of this Section with experience equivalent to installer and in good standing with the manufacturer.
- C. Engineer Qualifications: Registered professional engineer experienced in the design of rainscreen wall systems, anchors, fasteners and licensed to practice engineering in the jurisdiction where Project is located.
- D. Pre-Installation Meeting:
1. Discuss sequence and scheduling of work and interface with other trades.
  2. Review metal wall framing assemblies for potential interference and conflicts and coordinate layout and support provisions for interfacing work.
  3. Review and document methods, procedures and manufacturer's installation guidelines and safety procedures for exterior wall assembly.
- E. Mock-Ups: Materials in this section will be used in freestanding mockups. Coordinate mock-up materials and requirements with:
1. Division 04 Section "Stone Cladding"
  2. Division 07 Section "Formed Metal Wall Panels"
  3. Division 07 Section "Metal Composite Wall and Soffit Panels"

## 1.7 QUALITY CONTROL

- A. Single source responsibility:
1. Furnish engineered rainscreen attachment system components under direct responsibility of single manufacturer.
  2. Coordinate with the delegated design and shop drawings as required in Division 04 Section "Stone Veneer" and Division 07 Sections "Formed Metal Wall Panels" and "Metal Composite Wall & Soffit Panels."
- B. Field Measurements: Verify actual supporting and adjoining construction before fabrication.
- C. Record field measurements on project record shop drawings.
- D. Established Dimensions: Where field measurements cannot be made without delaying work, guarantee dimensions and proceed with fabrication of rainscreen attachment system corresponding to established dimensions.

## 1.8 DELIVERY, STORAGE AND HANDLING

- A. Delivery: Deliver materials and components in manufacturers' original, unopened and undamaged containers or bundles, fully identified. Exercise care to avoid damage during unloading, storing and installation.
- B. Store, protect and handle materials and components in accordance with manufacturer recommendations to prevent damage, contamination and deterioration. Keep materials clean, dry, and free of dirt and other foreign matter, and protect from damage due to weather or construction activities.

## **1.9 SEQUENCING**

- A. Ordering: Comply with manufacturers' ordering instructions and lead time requirements to avoid construction delays.
- B. Coordinate construction to ensure that assemblies fit properly to supporting and adjoining construction; coordinate schedule with construction in progress to avoid delaying work.

## **1.10 WARRANTY**

- A. Manufacturer Warranties:
- B. Attachment System: Ten (10) year Limited Warranty.
  - 1. Covers components of the attachment system, including structural failure of components when all the materials and components are supplied and installed per manufacturer's requirements.
  - 2. Includes labor and material for removal and replacement of defective material.
  - 3. Includes labor to remove and reinstall façade finish panels, finish closures and façade finish accessories necessary to access defective material.
- C. Contractor's Warranties: 2-year labor warranty, starting from Substantial Completion, to cover repair of materials found to be defective as a result of installation errors.
- D. Limitation of Warranties: Exclude repairs, replacement, and corrective work to the substrate, primary structure, finish panels, and/or property – unless otherwise noted above. Warranties exclude mechanical damage due to abuse, neglect, primary structure failure, or forces of nature greater than normal weather conditions.

## **1.11 MAINTENANCE**

- A. Extra Materials: For use by Owner in building maintenance and repair, provide 3 percent additional rainscreen attachment components in new, unopened cartons, packaged with protective covering for storage and identified with appropriate labels.

## **PART 2 - PRODUCTS**

### **2.1 RIGID INSULATION**

- A. Refer to Division 07 Section "Thermal Insulation."

### **2.2 RAINSCREEN ATTACHMENT/SUPPORT FRAMING SYSTEM**

- A. Comply with ANSI/ASHRAE 90.1-2010 definition of continuous insulation (c.i.).
- B. Material
  - 1. Type 304 Stainless Steel
- C. Spacing: Comply with manufacturer's Professional Engineer's calculations.
- D. Horizontal Girt: Stiffened horizontal girt with pre-punched drainage holes, directly attached on top of rigid insulation at regular spacing, with engineered thermally isolated washer assembly and fasteners.
  - 1. Steel Thickness: Minimum 0.046-inch thick (18 gauge).
  - 2. Profile Depth: 0.75 inches.
  - 3. Girt Fastening Face: 2-inches.
  - 4. Overall Girt Profile: 5-1/8-inches.
  - 5. Basis of Design: HCI by Knight Wall Systems.
  - 6. Or approved equivalent.

- E. Fasteners:
  - 1. Sufficient length to provide solid attachment through rigid insulation to structure as required by manufacturer.
  - 2. Thermal Isolating Washers: Minimum 0.125 inch thick Polyoxymethylene copolymer (POM) washers with integral centering lip to act as a thermal break between wall anchor fasteners and girt.
    - a. Tensile Yield Strength: 9.57 ksi per ISO 527.
    - b. Melting Temperature: 329 degrees Fahrenheit per ISO 3146.
    - c. Basis of Design: ThermaSto Isolator by Knight Wall Systems.
    - d. Or approved equivalent.
  - 3. Steel stud framing substrate: Self-drill hex-washer-head stainless steel with 1,000 hour salt-spray rated thermoset polyester coating.
    - a. Embedment depth: 0.625 inches or three full threads minimum, whichever is greater.
    - b. Minimum ultimate pull-out capacity from 18 gauge steel: 450 pounds.
- F. Accessories:
  - 1. Galvanic Protection: Utilize tapes and other methods as necessary to separate and prevent contact between dissimilar metals.

### **2.3 CLADDING PANEL**

- A. Refer to Division 04 Section "Stone Cladding"
- B. Refer to Division 07 Section "Formed Metal Wall Panels"
- C. Refer to Division 07 Section "Metal Composite Wall and Soffit Panels"

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and conditions for compliance with manufacturer requirements for installation conditions affecting performance of the work.
  - 1. Do not proceed with installation until unsatisfactory conditions have been corrected.
  - 2. Ensure weather-resistant barrier (WRB) and rigid insulation is installed prior to installing rainscreen attachment system.
  - 3. Ensure fenestration, transitions, discontinuities, sills, and ledgers are flashed and sealed to move moisture to the exterior of the building.
- B. Field verify architectural details and mechanical and electrical requirements prior to commencing installation.
- C. Commencement of installation constitutes acceptance of existing conditions and acceptance of responsibility for satisfactory performance.

### **3.2 RAINSCREEN ATTACHMENT SYSTEM INSTALLATION**

- A. Preparation:
  - 1. Verify horizontal girt does not cantilever past rigid insulation.
- B. Installation
  - 1. Coordinate layout and installation with stone veneer shop drawings and installer to review/confirm stone anchorage requirements.
  - 2. Install in strict accordance with manufacturer's installation instructions.
  - 3. Use laser or chalk line to mark starting height of horizontal girt.
  - 4. Do not use shims to plumb the wall between the horizontal girt and insulation.

5. Minimum length of installed cut girt is 24-inches and shall be attached with at least two (2) fasteners.
6. Mount stiffened horizontal girts, fastened up to 24 inches on center (or as determined by the manufactures engineering calculations) over installed rigid insulation, using one self-tapping screw with thermal isolator, for each pre-punched attachment hole at spacing indicated on engineering calculations.
  - a. Check plumb of horizontal girts both parallel and perpendicular to the structure.
  - b. Tighten screws that attach horizontal girt through insulation to substructure to a snug tight condition and not stripped. Do not over-torque beyond manufacturer's recommendation. If installed using hand tools, verify for each installer at beginning of project using snug-tight criteria. Do not use stripped holes.
  - c. Where obstructions are present and unavoidable (i.e. window openings), use laser or chalk line to restart girt.
  - d. Use shearing instruments (i.e. snips, nibbler, etc.) for cutting metal framing components. Saws are not recommended, as the sparks produced during cutting will damage the anti-corrosion coating. If sparks are generated during cutting, be sure the portion of the component to be installed on the building is protected from sparks and that any stockpile near the cutting station is also protected.
  - e. The systems components should not be cut while installed on the building, unless using a shearing instrument.
  - f. Replace thermal isolator pieces that break during installation.
  - g. Provide a 3/8" – 1/2" gap between girts for expansion when multiple lengths of horizontal girts are installed.

### **3.3 SIDING / CLADDING PANEL INSTALLATION**

- A. Refer to Division 04 Section "Stone Cladding"
- B. Refer to Division 07 Section "Formed Metal Wall Panels"
- C. Refer to Division 07 Section "Metal Composite Wall and Soffit Panels"
- D. The cavity must be clear and free from air flow and drainage obstructions.

### **3.4 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  1. Aluminum.
  2. Steel.
  3. Plastic Materials
  4. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 07 48 00**

## **SECTION 07 54 19 - POLYVINYL-CHLORIDE (PVC) ROOFING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  1. Adhered polyvinyl chloride (PVC) roofing system.
  2. Substrate board.
  3. Vapor retarder.
  4. Roof insulation.
  5. Cover board.
  6. Walkways.
  7. Premanufactured metal copings and roof edge flashings.
- B. Related Requirements:
  1. Division 06 Section "Rough Carpentry" for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.
  2. Division 07 Section "Thermal Insulation" for closed-cell spray foam insulation.
  3. Division 07 Section "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
  4. Division 22 Section "Storm Drainage Piping Specialties" for roof drains.

#### **1.3 DEFINITIONS**

- A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.

#### **1.4 PREINSTALLATION MEETINGS**

- A. Preliminary and Preinstallation Roofing Conferences: Before starting roof deck construction, conduct one or more conferences at Project site.
  1. Meet with Owner, Architect, Construction Manager, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
  2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
  3. Review extent of existing roof to remain and all areas where new roof will adjoin and seal to old roof.
  4. Review photovoltaic system presently installed on existing roof. Develop strategy to work with PV system owner/installer to coordinate roofing work with necessary relocations of PV panels.
  5. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  6. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
  7. Review structural loading limitations of roof deck during and after roofing.
  8. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
  9. Review governing regulations and requirements for insurance and certificates if applicable.



10. Review temporary protection requirements for roofing system during and after installation.
11. Review roof observation and repair procedures after roofing installation.

## 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  1. For insulation and roof system component fasteners, include copy of FM Approvals' RoofNav listing.
- B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:
  1. Layout and thickness of insulation.
  2. Base flashings and membrane terminations.
  3. Flashing details at penetrations.
  4. Tapered insulation thickness and slopes.
  5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
  6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
  7. Tie-in with air barrier.
  8. Details at all intersections between existing roof insulation and membrane to remain and new roof.
  9. Details pertaining to PV installations over new roof.
- C. Samples for Verification: For the following products:
  1. Roof membrane and flashing, of color required.
  2. Walkway pads or rolls, of color required.
- D. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Manufacturer Certificates:
  1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
    - a. Submit evidence of compliance with performance requirements.
  2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.
- C. Product Test Reports: For roof membrane and insulation, tests performed by independent qualified testing agency indicating compliance with specified requirements.
- D. Evaluation Reports: For components of roofing system, from ICC-ES.
- E. Letter of Verification of Compatibility:
  1. Provide letter to verify compatibility of products in this section which come into contact with those listed in the following sections, as shown in the Architectural Drawings:
    - a. Division 07 Section "Fluid-Applied Membrane Air Barriers."
    - b. Division 07 Section "Fluid Applied Insulation Coating."
    - c. Division 07 Section "Pre-Applied Sheet Membrane Waterproofing."
    - d. Division 07 Section "Self-Adhering Sheet Waterproofing."
    - e. Division 07 Section "Thermal Insulation," especially spray applied.
    - f. Division 07 Section "Applied Fireproofing."
    - g. Division 07 Section "Polyvinyl-Chloride (PVC) Roof."

- h. Division 07 Section "Sheet Metal Flashing & Trim."
  - i. Division 07 Section "Flexible Stainless Steel Flashing."
  - j. Division 08 Section "Glazed Alum Curtain Walls," especially the Extruded Silicone Air and Vapor Barrier Transitions.
2. Provide additional testing as required to verify compatibility.

- F. Field Test Reports:
- 1. Concrete internal relative humidity test reports.
  - 2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.
- G. Field quality-control reports.
- H. Sample Warranties: For manufacturer's special warranties.

## **1.7 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For roofing system to include in maintenance manuals.
- B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

## **1.8 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: A qualified manufacturer that is listed in FM Approvals' RoofNav for roofing system identical to that used for this Project.
- B. Roofing membrane manufacturer must have demonstrated performance history of producing PVC roof membranes no less, in duration of years, than the warranty duration specified.
- C. Roofing System Manufacturer must have published "Cradle to Grave" Environmental Product Declarations. "An EPD® (Environmental Product Declaration) is an independently verified and registered document that communicates transparent and comparable information about the life-cycle environmental impact of products." Typically EPDs are "Cradle to Gate" which covers the manufacturing process through distribution to the market but with "Cradle to Grave" it extends the life cycle analysis to the end of a product's service life.
- D. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
- E. Provide in place mockups of the following:
  - 1. Curb transition between existing and new roof membranes, 5' minimum length.
  - 2. Parapet and coping at top of slate wall, 5' minimum length.
  - 3. Parapet and coping at top of curtain wall, 5' minimum length.

## **1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
  - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

#### **1.10 FIELD CONDITIONS**

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

#### **1.11 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
  - 1. Special warranty includes roof membrane, base flashings, roof insulation, fasteners, cover boards, substrate board, and other components of roofing system.
  - 2. Warranty Period: 20 or 30 years from date of Substantial Completion.
  - 3. Warranty for balcony with pavers: 20 years from date of Substantial Completion.

### **PART 2 - PRODUCTS**

#### **2.1 PERFORMANCE REQUIREMENTS**

- A. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings shall remain watertight.
  - 1. Accelerated Weathering: Roof membrane shall withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
  - 2. Impact Resistance: Roof membrane shall resist impact damage when tested according to ASTM D3746, ASTM D4272/D4272M, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.
- B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.
- C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897:
  - 1. Zone 1 (Roof Area Field): 60psf
  - 2. Zone 2 (Roof Area Perimeter): 105psf
  - 3. Zone 3 (Roof Area Corners): 105psf
- D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials shall comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and shall be listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.
  - 1. Fire/Windstorm Classification: Class 1A-90
  - 2. Hail-Resistance Rating: SH. Retain applicable "Solar Reflectance Index," "ENERGY STAR Listing," or "Energy Performance" Paragraph below if "cool-roof" performance is required. Verify that PVC roof membrane specified complies before retaining.
- E. ENERGY STAR Listing: Roofing system shall be listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.

- F. Energy Performance: EnergySmart White, initial solar reflectance of 0.83, emittance of 0.90, and solar reflective index (SRI) of 104.
- G. Exterior Fire-Test Exposure: ASTM E108 or UL 790, Class A

## 2.2 POLYVINYL CHLORIDE (PVC) ROOFING

- A. Membrane Shall Conform to:
  - 1. NSF/ANSI Standard 347, "Sustainability Assessment for Single Ply Roofing Membranes". Certification Level: **Platinum**.
  - 2. The manufacture to guarantee that the membrane thickness meets or exceeds the specified thickness when tested according to ASTM D751
- B. PVC Sheet: ASTM D4434/D4434M, Type II, glass-fiber reinforced.
  - 1. **Manufacturers:** Subject to compliance with requirements, provide products by the following:
    - a. Sika Sarnafil G 410 EnergySmart Roof Membrane with lacquer coating, or approved equivalent.
  - 2. Thickness: 80 mils MINIMUM THICKNESS – ASTM tolerance of 10% variance will not be accepted.
  - 3. Exposed Face Color: EnergySmart White, initial solar reflectance of 0.83, emittance of 0.90, and solar reflective index (SRI) of 104.
- C. Source Limitations: Obtain components for roofing system from roof membrane manufacturer.

## 2.3 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
  - 1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as PVC sheet.
- C. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- D. Bonding Adhesive: Manufacturer's standard.
- E. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- F. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.
- G. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

## 2.4 PERIMETER EDGE FLASHING

- A. Edge Grip Extruded Fascia
  - 1. A heavy-duty prefabricated perimeter edge system provided by Sika Corporation. The system has concealed fasteners with no penetrations on the horizontal roof surface and includes fasteners and splice plates. Edge Grip Extruded is made from two distinct parts. A heavy-duty extruded retainer base plate and a decorative snap-on fascia cover.
  - 2. Retainer base plate shall be 0.10 inch aluminum in 10 ft. lengths.
  - 3. Snap-on fascia cover shall be 0.063 inch aluminum in 10 ft. lengths.

4. Snap-on fascia cover shall have a custom Kynar finish to match adjacent curtain wall.
5. Provide matching corners, end caps, fascia sumps, spillouts, etc. as required.

B. Wall Grip Formed Coping Plus

1. A heavy-duty prefabricated perimeter coping system provided by Sika Corporation. The system has concealed fasteners with no penetrations on the horizontal roof surface and includes fasteners and splice plates. Wall Grip Formed Coping Plus is made from two distinct parts: a heavy-duty extruded cleat and a decorative snap-on coping cover.
2. Continuous cleat shall be 16 Ga galvanized steel in 10 ft. lengths.
3. Snap-on coping cover shall be 0.063 inch aluminum in 10 ft. lengths.
4. Snap-on coping cover shall have a custom Kynar finish to match adjacent curtain wall.
5. Provide matching corners, end caps, fascia sumps, spillouts, etc. as required.

## 2.5 SUBSTRATE BOARDS

A. Substrate Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum substrate or ASTM C1278/C1278M, fiber-reinforced gypsum board.

1. Manufacturers: Subject to compliance with requirements, provide the following product or approved equivalent:
  - a. Dens Deck by Georgia-Pacific Gypsum LLC.
2. Thickness: 5/8 inch.
3. Surface Finish: Unprimed.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

## 2.6 VAPOR RETARDER / VAPOR RETARDER PRIMER

A. Vapor Retarder Primer VC

1. A VOC Compliant, solvent-based primer used to prime wood, concrete, lightweight concrete, gypsum boards and decks, and DensDeck® boards prior to the application of Sika's self-adhered vapor retarders.

B. Vapor Retarder SA 31: 31 mil thick self-adhesive vapor retarder / air barrier.

1. Self-adhesive SBS modified bitumen with a tri-laminated woven polyethylene facer.

## 2.7 ROOF INSULATION

A. General: Preformed roof insulation boards manufactured by PVC roof membrane manufacturer, approved for use in FM Approvals' RoofNav listed roof assemblies.

B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 2, Grade 2, glass-fiber mat facer on both major surfaces.

1. Sarnatherm CG
2. Compressive Strength: 25 psi.
3. Size: 48 by 48 inches.
4. Thickness: As indicated on Drawings.

C. Tapered Insulation: Provide factory-tapered insulation boards.

1. Material: Match roof insulation.
2. Minimum Thickness: 1/4 inch.
3. Slope:
  - a. Roof Field: 1/4 inch per foot unless otherwise indicated on Drawings.
  - b. Saddles and Crickets: 1/2 inch per foot Insert slope unless otherwise indicated on Drawings.

## **2.8 INSULATION ACCESSORIES**

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.
- B. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
  - 1. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
- C. Cover Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum board or ASTM C1278/C1278M fiber-reinforced gypsum board.
  - 1. Thickness: 1/4 inch.
  - 2. Surface Finish: Factory primed

## **2.9 DRAINAGE COMPOSITE**

- A. Geonet B
  - 1. A polymeric drainage net with polypropylene geotextile laminated to both sides.

## **2.10 WALKWAYS**

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway rolls, approximately 3/16 inch thick and acceptable to roofing system manufacturer.
  - 1. Sarnatred-V, with a chevron textured surface pattern to prevent slipping.
  - 2. Size: Approximately 39 inches
  - 3. Color: Light Gray
  - 4. Passes UL 410 "Slip Resistance of Floor Surface Material."

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
  - 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
  - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
  - 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 5 Section "Steel Decking."
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

### **3.3 ROOFING INSTALLATION, GENERAL**

- A. Install roofing system according to roofing system manufacturer's written instructions, FM Approvals' RoofNav assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.

- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
- C. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing roofing system.
- D. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under Division 07 Section "Fluid-Applied Membrane Air Barriers."

### 3.4 SUBSTRATE BOARD INSTALLATION

- A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches in adjacent rows.
  - 1. At steel roof decks, install substrate board at right angle to flutes of deck.
    - a. Locate end joints over crests of steel roof deck.
  - 2. Tightly butt substrate boards together.
  - 3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
  - 4. Fasten substrate board to top flanges of steel deck according to recommendations in FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.

### 3.5 VAPOR RETARDER INSTALLATION

- A. Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 and 6 inches, respectively.
  - 1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
  - 2. Seal laps by rolling.
- B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

### 3.6 INSULATION INSTALLATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Installation Over Metal Decking:
  - 1. Install base layer of insulation with joints staggered not less than **24 inches** in adjacent rows
    - a. Locate end joints over crests of decking.
    - b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    - c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
    - d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
      - 1) Trim insulation so that water flow is unrestricted.
    - e. Fill gaps exceeding 1/4 inch with insulation.
    - f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
  - 2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.
    - a. Staggered end joints within each layer not less than 24 inches in adjacent rows.

- b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
- c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
- d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
- e. Trim insulation so that water flow is unrestricted.
- f. Fill gaps exceeding 1/4 inch with insulation.
- g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- h. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification, as follows:
  - 1) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

### **3.7 INSTALLATION OF COVER BOARDS**

- A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.
  - 1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
  - 2. At internal roof drains, conform to slope of drain sump.
    - a. Trim cover board so that water flow is unrestricted.
  - 3. Cut and fit cover board tight to nailers, projections, and penetrations.
  - 4. Adhere cover board to substrate using adhesive according to FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification, as follows:
    - a. Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

### **3.8 ADHERED ROOFING INSTALLATION**

- A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
- B. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
- C. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.
- E. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.
- F. Apply roof membrane with side laps shingled with slope of roof deck where possible.
- G. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.
  - 1. Test lap edges with probe to verify seam weld continuity.
  - 2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
  - 3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.



- H. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

### **3.9 BASE FLASHING INSTALLATION**

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

### **3.10 DRAINAGE COMPOSITE INSTALLATION**

- A. Install only in areas indicated on drawings to receive pedestal pavers.
- B. Install drainage composite directly over the waterproofing membrane and/or protection layer. If protection layer is not specified, install drainage composite immediately after Sika Sarnafil's inspection and acceptance of the waterproofing installation.
- C. Neatly trim drainage composite to fit closely around penetrations and at the base of all drains to ensure that water will flow freely from composite into drain openings.
- D. All cut edges of the drainage composite shall be covered in order to protect the waterproofing membrane from damage.

### **3.11 EDGE METAL INSTALLATION**

- A. All flashings shall be installed concurrently with the roof membrane as the job progresses. No temporary flashings shall be allowed without the prior written approval of the Owner's Representative and Sika Corporation. Acceptance shall only be for specific locations on specific dates. If any water is allowed to enter under the newly completed roofing due to incomplete flashings, the affected area shall be removed and replaced at the Applicator's expense.
- B. Edge Grip Extruded Fascia & Wall Grip Coping
  1. Position the roof membrane over edge of roof and down outside face of wall covering wood nailer(s) completely. Allow 1/2 inch (13 mm) of excess membrane to extend down past the wood nailer. Hot-air weld all seams making sure there are no voids in welds.
  2. Apply a 3/8 inch (10 mm) continuous bead of Sikaflex – 1a sealant to the clean bottom of heavy-duty extruded retainer. Install extruded retainer from right to left as seen from rooftop. Field cut sections as necessary.
  3. Install retainer splice under intersecting sections of extruded retainer.
  4. Fasten extruded retainer into side of nailer 12 inches (0.3 m) on center. Use fasteners provided with Edge Grip Extruded and Wall Grip Coping systems; 1-1/2 inch (38 mm) hex head stainless steel fasteners with neoprene washers. Allow 1/8 inch (3 mm) gap between extruded retainer sections for thermal expansion [1/4 inch (6 mm) if temperature is below 40°F (4°C)].
  5. Fasteners shall provide a minimum 240 lbs. (109 kg) pull-out resistance; suitable for the substrates to which being installed.

6. Install concealed joint splice plates at intersecting sections of snap-on fascia and coping cover joints.
7. Position snap-on fascia and coping cover so that its top engages the extruded retainer top. Rotate downward engaging bottoms of snap-on fascia and coping cover and extruded retainer base plate. Allow 1/4 inch (6 mm) gap between snap-on fascia and coping sections for thermal expansion. Field cut where necessary.

### **3.12 WALKWAY INSTALLATION**

- A. Flexible Walkways: Install walkway products according to manufacturer's written instructions.
  1. Install flexible walkways at the following locations:
    - a. Perimeter of each rooftop unit.
    - b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
    - c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
    - d. Top and bottom of each roof access ladder.
    - e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
    - f. Locations indicated on Drawings.
    - g. As required by roof membrane manufacturer's warranty requirements.
  2. Provide 6-inch clearance between adjoining pads.
  3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

### **3.13 FIELD QUALITY CONTROL**

- A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.
- B. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

### **3.14 PROTECTING AND CLEANING**

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

**END OF SECTION 07 54 19**

## **SECTION 07 62 00 - SHEET METAL FLASHING & TRIM**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Through wall flashing.
  - 2. Formed wall sheet metal fabrications.
  - 3. Formed equipment support flashing.
  - 4. Formed overhead-piping safety pans.
- B. Related Requirements:
  - 1. Division 04 Section "Unit Masonry" for associated metal flashing requirements.
  - 2. Division 04 Section "Stone Masonry" for associated metal flashing requirements.
  - 3. Division 04 Section "Stone Cladding" for associated metal flashing requirements.
  - 4. Division 04 Section "Cast Stone Masonry" for associated metal flashing requirements.
  - 5. Division 07 Section "Metal Composite Wall & Soffit Panels" for associated metal flashing requirements.
  - 6. Division 07 Section "Formed Metal Wall Panels" for associated metal flashing requirements.
  - 7. Division 07 Section "PVC Roofing" for associated metal flashing requirements.
  - 8. Division 8 Section "Sloped Glazing" for associated metal flashing requirements.
  - 9. Division 8 Section "Glazed Aluminum Curtain Walls" for associated metal flashing requirements.

#### **1.3 COORDINATION**

- A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

#### **1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 2. Review requirements for insurance and certificates if applicable.
  - 3. Review sheet metal flashing observation and repair procedures after flashing installation.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data:
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
- B. Shop Drawings: For sheet metal flashing and trim.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.

3. Include identification of material, thickness, weight, and finish for each item and location in Project.
  4. Include details for forming, including profiles, shapes, seams, and dimensions.
  5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
  6. Include details of termination points and assemblies.
  7. Include details of special conditions.
  8. Include details of connections to adjoining work.
  9. Detail formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches.
- C. Samples: For each exposed product and for each color and texture specified, 12 inches long by actual width.
- D. Samples for Initial Selection: For each type of sheet metal and accessory indicated with factory-applied finishes.
- E. Samples for Verification: For each type of exposed finish.
1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
  2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.
  3. Unit-Type Accessories and Miscellaneous Materials: Full-size Sample.

## **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For fabricator.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Letter of Verification of Compatibility:
1. Provide letter to verify compatibility of products in this section which come into contact with those listed in the following sections, as shown in the Architectural Drawings:
    - a. Division 07 Section "Fluid-Applied Membrane Air Barriers."
    - b. Division 07 Section "Fluid Applied Insulation Coating."
    - c. Division 07 Section "Pre-Applied Sheet Membrane Waterproofing."
    - d. Division 07 Section "Self-Adhering Sheet Waterproofing."
    - e. Division 07 Section "Thermal Insulation," especially spray applied.
    - f. Division 07 Section "Applied Fireproofing."
    - g. Division 07 Section "Polyvinyl-Chloride (PVC) Roof."
    - h. Division 07 Section "Sheet Metal Flashing & Trim."
    - i. Division 07 Section "Flexible Stainless Steel Flashing."
    - j. Division 08 Section "Glazed Alum Curtain Walls," especially the Extruded Silicone Air and Vapor Barrier Transitions.
  2. Provide additional testing as required to verify compatibility.
- D. Sample Warranty: For special warranty.

## **1.7 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For sheet metal flashing and trim, and its accessories, to include in maintenance manuals.
- B. Special warranty.

## **1.8 QUALITY ASSURANCE**

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
  - 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations in writing.
  - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
  - 3. Materials in this section may be required in freestanding mockups.

## **1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
  - 1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
  - 2. Protect stored sheet metal flashing and trim from contact with water.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

## **1.10 WARRANTY**

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta units when tested in accordance with ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. General: Sheet metal flashing and trim assemblies, including cleats, anchors, and fasteners, shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

- D. Dissimilar Metals: Provide adequate separation between all dissimilar metals, as well as between metals and related building materials known to have a corrosive effect on metals

## **2.2 SHEET METALS**

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- B. Aluminum Sheet: ASTM B209, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.
  - 1. As-Milled Finish: Mill.
  - 2. Exposed Coil-Coated Finish:
    - a. Metallic Fluoropolymer: AAMA 2605. Three-coat fluoropolymer finish with suspended metallic flakes containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - b. Color: Match Architect's sample.
  - 3. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.
  - 4. Use aluminum flashing only where noted on Drawings.
- C. Stainless Steel Sheet: ASTM A240/A240M, Type 304, dead soft, fully annealed; with smooth, flat surface.
  - 1. Finish: ASTM A480/A480M, No. 2D (dull, cold rolled).
    - a. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
  - 2. Use stainless steel flashing unless noted otherwise.

## **2.3 MISCELLANEOUS MATERIALS**

- A. General: Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by manufacturer of primary sheet metal unless otherwise indicated.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by manufacturer of primary sheet metal.
  - 1. General: Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
    - a. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating. Provide metal-backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
    - b. Blind Fasteners: High-strength aluminum or stainless steel rivets suitable for metal being fastened.
  - 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
  - 3. Fasteners for Stainless Steel Sheet: Series 300 stainless steel.
- C. Solder:
  - 1. For Stainless Steel: ASTM B32, Grade Sn60, with acid flux of type recommended by stainless steel sheet manufacturer.
- D. Sealant Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.

- E. Elastomeric Sealant: ASTM C920, elastomeric silicone polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type expansion joints with limited movement.
- G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- H. Bituminous Coating: Cold-applied asphalt emulsion in accordance with ASTM D1187/D1187M.
- I. Asphalt Roofing Cement: ASTM D4586, asbestos free, of consistency required for application.

## **2.4 FABRICATION, GENERAL**

- A. Custom fabricate sheet metal flashing and trim to comply with details indicated and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required.
  - 1. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
  - 2. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
  - 3. Verify shapes and dimensions of surfaces to be covered and obtain field measurements for accurate fit before shop fabrication.
  - 4. Form sheet metal flashing and trim to fit substrates without excessive oil-canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
  - 5. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.
- B. Fabrication Tolerances:
  - 1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.
  - 2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified.
- C. Expansion Provisions: Form metal for thermal expansion of exposed flashing and trim.
  - 1. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.
  - 2. Use lapped expansion joints only where indicated on Drawings.
- D. Sealant Joints: Where movable, nonexpansion-type joints are required, form metal in accordance with cited sheet metal standard to provide for proper installation of elastomeric sealant.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.
- G. Seams:
  - 1. Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.

2. Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.
  3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer.
- H. Do not use graphite pencils to mark metal surfaces.

## **2.5 WALL SHEET METAL FABRICATIONS**

- A. Through-Wall Flashing: Fabricate continuous flashings in minimum 96-inch-long, but not exceeding 12-foot-long, sections, under copings, and at shelf angles. Fabricate discontinuous lintel, sill, and similar flashings to extend 6 inches beyond each side of wall openings; and form with 2-inch-high, end dams. Fabricate from the following materials:
1. Stainless Steel: 0.024 inch thick.
- B. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch-high, end dams. Fabricate from the following materials:
1. Stainless Steel: 0.024 inch thick.
- C. Termination Bar: 1" high 26 gauge stainless steel termination bar with sealant lip.
1. No prepunched holes. Holes for fasteners to be drilled at appropriate locations in the field.

## **2.6 MISCELLANEOUS SHEET METAL FABRICATIONS**

- A. Equipment Support Flashing: Fabricate from the following materials:
1. Stainless Steel: 0.024 inch thick.
- B. Overhead-Piping Safety Pans: Fabricate from the following materials:
1. Stainless Steel: 0.024 inch thick.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
1. Verify compliance with requirements for installation tolerances of substrates.
  2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
  3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Field Measurements: Perform sheet metal flashing and trim work in cooperation with other trades and Contractors. Where possible, verify size, location and placement of miscellaneous sheet metal flashing and trim work prior to fabrication. Coordinate field measurements and shop drawings with fabrication and shop assembly.

### **3.2 INSTALLATION, GENERAL**

- A. Install sheet metal flashing and trim to comply with details indicated and recommendations of cited sheet metal standard that apply to installation characteristics required unless otherwise indicated on Drawings.



1. Install fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
  2. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder or sealant.
  3. Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement.
  4. Install sheet metal flashing and trim to fit substrates and to result in watertight performance.
  5. Install continuous cleats with fasteners spaced not more than 12 inches o.c.
  6. Space individual cleats not more than 12 inches apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.
  7. Install exposed sheet metal flashing and trim with limited oil-canning, and free of buckling and tool marks.
  8. Do not field cut sheet metal flashing and trim by torch.
  9. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by sheet metal manufacturer or cited sheet metal standard.
1. Coat concealed side of uncoated-aluminum and stainless steel sheet metal flashing and trim with bituminous coating where flashing and trim contact wood, ferrous metal, or cementitious construction.
  2. Underlayment: Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with slip sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim.
1. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.
  2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.
  3. Use lapped expansion joints only where indicated on Drawings.
- D. Expansion Provisions: Provide for thermal expansion of concealed flashing.
1. Space movement joints in longitudinal runs at a maximum of 10 feet with no joints within 24 inches of corner or intersection.
  2. Form expansion joints by lapping flashing 4"-6" and seal with three rows of non-curing butyl.
  3. Isolate corners and end dams with slip joints that are 12"-24" away from transition.
- E. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- F. 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.
- G. Seal joints as required for watertight construction.
1. Use sealant-filled joints unless otherwise indicated.
    - a. Embed hooked flanges of joint members not less than 1 inch into sealant.
    - b. Form joints to completely conceal sealant.
    - c. When ambient temperature at time of installation is between 40 and 70 deg F, set joint members for 50 percent movement each way.
    - d. Adjust setting proportionately for installation at higher ambient temperatures.
      - 1) Do not install sealant-type joints at temperatures below 40 deg F.
  2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

- H. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.
1. Pre-tin edges of sheets with solder to width of 1-1/2 inches; however, reduce pre-tinning where pre-tinned surface would show in completed Work.
  2. Do not use torches for soldering.
  3. Heat surfaces to receive solder, and flow solder into joint.
    - a. Fill joint completely.
    - b. Completely remove flux and spatter from exposed surfaces.
  4. Stainless Steel Soldering:
    - a. Tin edges of uncoated sheets, using solder for stainless steel and acid flux.
    - b. Promptly remove acid-flux residue from metal after tinning and soldering.
    - c. Comply with solder manufacturer's recommended methods for cleaning and neutralization.
  5. Provide fully soldered stainless steel flashing caps for stone copings installed with dowels.

### **3.3 INSTALLATION OF ROOF FLASHINGS**

- A. Install sheet metal flashing and trim to comply with performance requirements and cited sheet metal standard.
1. Provide concealed fasteners where possible, and set units true to line, levels, and slopes.
  2. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Copings:
1. Install roof edge flashings in accordance with ANSI/SPRI/FM 4435/ES-1.
  2. Anchor to resist uplift and outward forces in accordance with recommendations in cited sheet metal standard unless otherwise indicated.
    - a. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 16-inch centers.
    - b. Anchor interior leg of coping with washers and screw fasteners through slotted holes at 24-inch centers.
  3. Anchor to resist uplift and outward forces in accordance with recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for specified FM Approvals' listing for required windstorm classification.

### **3.4 INSTALLATION OF WALL FLASHINGS**

- A. Install sheet metal wall flashing to intercept and exclude penetrating moisture in accordance with cited sheet metal standard unless otherwise indicated. Coordinate installation of wall flashing with installation of wall-opening components such as windows, doors, and louvers.
- B. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings.

### **3.5 INSTALLATION OF MISCELLANEOUS FLASHING**

- A. Equipment Support Flashing:
1. Coordinate installation of equipment support flashing with installation of roofing and equipment.
  2. Weld or seal flashing with elastomeric sealant to equipment support member.
- B. Overhead-Piping Safety Pans:
1. Suspend pans from structure above, independent of other overhead items such as equipment, piping, and conduit, unless otherwise indicated on Drawings.
  2. Pipe and install drain line to plumbing waste or drainage system.

### **3.6 INSTALLATION TOLERANCES**

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

### **3.7 CLEANING**

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.

### **3.8 PROTECTION**

- A. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended in writing by sheet metal flashing and trim manufacturer.
- C. Maintain sheet metal flashing and trim in clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures, as determined by Architect.

### **3.1 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Stainless steel and aluminum.
  - 2. Plastic Materials and Gaskets.
  - 3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 07 62 00**

## SECTION 07 65 00 – FLEXIBLE STAINLESS STEEL FLASHING [ALTERNATE]

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Non-asphaltic, laminated stainless steel fabric flashing.
- B. This section is an **ALTERNATE** for the solid stainless steel through wall flashing specified in Division 07 Section "Sheet Metal Flashing & Trim." It is to be substituted for the following building components:
  - 1. Stainless steel through wall flashing.
  - 2. Stainless steel head and sill flashing.
- C. This product is **NOT** to be substituted for solid stainless steel flashing in these locations:
  - 1. Full width cap flashing under copings or wall caps.
  - 2. At the base of or associated with curtain wall or skylights.
  - 3. Flashing associated with Division 07 Section "Formed Metal Wall Panels."
  - 4. At locations where flashings are listed to be provided within specification sections other than "Sheet Metal Flashing & Trim".
- D. Related Requirements:
  - 1. Division 04 Section "Unit Masonry" for associated metal flashing requirements.
  - 2. Division 04 Section "Stone Masonry" for associated metal flashing requirements.
  - 3. Division 04 Section "Stone Cladding" for associated metal flashing requirements.
  - 4. Division 04 Section "Cast Stone Masonry" for associated metal flashing requirements.
  - 5. Division 07 Section "Sheet Metal Flashing & Trim" for flashings other than through wall flashing.

#### 1.3 COORDINATION

- A. Coordinate flexible flashing layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.
- B. Coordinate flexible flashing installation with adjoining roofing and wall materials, joints, and seams to provide leakproof, secure, and noncorrosive installation.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review construction schedule. Verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 2. Review requirements for insurance and certificates if applicable.
  - 3. Review flexible flashing observation and repair procedures after flashing installation.

#### 1.5 ACTION SUBMITTALS

- A. Product Data:
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.

- B. Shop Drawings: For flexible flashing and accessories.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Detail fabrication and installation layouts, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled Work.
  - 3. Include identification of material, thickness, weight, and finish for each item and location in Project.
  - 4. Include details for forming, including profiles, shapes, seams, and dimensions.
  - 5. Include details for joining, supporting, and securing, including layout and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.
  - 6. Include details of termination points and assemblies.
  - 7. Include details of special conditions.
  - 8. Include details of connections to adjoining work.
  - 9. Detail formed flashing and trim at scale of not less than 1-1/2 inches per 12 inches.
  
- C. Samples: For each exposed product and for each color and texture specified, 12 inches long by actual width.
  
- D. Samples for Initial Selection: For each type of flexible flashing and accessory indicated with factory-applied finishes.
  
- E. Samples for Verification: For each type of exposed finish.
  - 1. Sheet Metal Flashing: 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
  - 2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches long and in required profile. Include fasteners and other exposed accessories.
  - 3. Unit-Type Accessories and Miscellaneous Materials: Full-size Sample.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Product Quality & Environmental submittals:
  - 1. **Certificates:**
    - a. Indicate materials supplied or installed are asbestos free.
    - b. Indicate recycled content: 60% total recycled material; based on 60% Post Industrial Recycled Content.
  - 2. **Performance Attributes**
    - a. Tensile strength, 100,000 psi minimum average
    - b. Puncture Resistance, 2,500 pounds average
    - c. When tested as manufactured, product resists growth of mold pursuant to test method ASTM-D3273.
    - d. Fire Rating: flame spread and smoke generation
      - 1) Rated Class A, ASTM E84
    - e. Certify the use of domestic manufactured stainless steel for flashing.
    - f. Certify products contain no silica or asbestos.
  
- B. Letter of Verification of Compatibility:
  - 1. Provide letter to verify compatibility of products in this section which come into contact with those listed in the following sections, as shown in the Architectural Drawings:
    - a. Division 07 Section "Fluid-Applied Membrane Air Barriers."
    - b. Division 07 Section "Fluid Applied Insulation Coating."
    - c. Division 07 Section "Pre-Applied Sheet Membrane Waterproofing."
    - d. Division 07 Section "Self-Adhering Sheet Waterproofing."
    - e. Division 07 Section "Thermal Insulation," especially spray applied.
    - f. Division 07 Section "Applied Fireproofing."
    - g. Division 07 Section "Polyvinyl-Chloride (PVC) Roof."
    - h. Division 07 Section "Sheet Metal Flashing & Trim."
    - i. Division 07 Section "Flexible Stainless Steel Flashing."

- j. Division 08 Section "Glazed Alum Curtain Walls," especially the Extruded Silicone Air and Vapor Barrier Transitions.
  - 2. Provide additional testing as required to verify compatibility.
- C. Sample Warranty: For special warranty.

### **1.7 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For flexible flashing and trim, and its accessories, to include in maintenance manuals.
- B. Special warranty.

### **1.8 QUALITY ASSURANCE**

- A. Qualifications:
  - 1. Manufacturer: Provide flashing materials by single manufacturer with not less than twenty five years of experience in manufacturing flexible flashing products.
  - 2. Flashing materials must be able to withstand 300° F temperature without changing the long term performance of the flashing.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
  - 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations in writing.
  - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
  - 3. Materials in this section may be required in freestanding mockups.

### **1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
  - 1. Store sheet metal flashing and trim materials away from uncured concrete and masonry.
  - 2. Protect stored sheet metal flashing and trim from contact with water.
- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

### **1.10 WARRANTY**

- A. Special warranty:
  - 1. Manufacturer: Warrant flexible flashing material for life of the wall.
  - 2. Begin warranty at Date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURED UNITS**

- A. Flexible flashing:
  - 1. Basis of Design: York Manufacturing's Multi-Flash SS, or approved equivalent.
  - 2. Characteristics:
    - a. Type: Stainless steel core with polymer fabric laminated to the bottom stainless steel face with non-asphalt adhesive. The top face (exposed side) must not be covered with a polymer fabric.

- b. Stainless steel: type 304, ASTM A240. Domestically sourced per DFARS 252.225-7008 and/or DFARS 252.225-7009.
- c. Fabric: polymer fabric; laminated back face (non-exposed side) of stainless steel core.
- d. Size: Manufacturer's standard width rolls.

## 2.2 ACCESSORIES

- A. Mastic/sealant: Product standard of quality is York Manufacturing, Inc.; UniverSeal US100, or approved equivalent.
  - 1. Characteristics:
    - a. Type: One part 100% solids, solvent-free formulated silyl-terminated polyether (STPE), ASTM C920-11, Type S, Grade NS, Class 50.
- B. Preformed outside and inside corners
  - 1. Manufacturer's standard prefabricated units
  - 2. Stainless steel: 26 gauge stainless steel.
- C. Preformed end dams
  - 1. Manufacturer's standard prefabricated units
  - 2. Stainless steel: 26 gauge stainless steel.
- D. Splice material: York304 SS by York, or approved equivalent.
  - 1. Manufacturer's standard self-adhered metal material; material matching system material or use Multi-Flash Stainless Steel 6" lap piece and polyether sealant as a splice.
  - 2. Provide Interlocking Lapped Splice Joint with sealant and self-adhesive flashing – see details on sheet A0.70.
- E. Termination bar: York T-96 termination bar.
  - 1. Manufacturer's standard 1" composite material bar.
  - 2. No prepunched holes. Holes for fasteners to be drilled at appropriate locations in the field.
- F. Repair and other materials/accessories: Manufacturer's standard.
- G. Fasteners: Domestic manufactured fastener types and sizes recommended by flashing manufacturer for intended use.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the Work.
  - 1. Verify compliance with requirements for installation tolerances of substrates.
  - 2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
  - 3. Verify that air- or water-resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
- C. Field Measurements: Perform flexible flashing in cooperation with other trades and Contractors. Coordinate field measurements and shop drawings with fabrication and shop assembly.

### **3.2 INSTALLATION**

#### **A. General:**

1. Install where indicated, specified, or required in accord with flashing manufacturer's written instructions and as follows.
2. Extend flashing 6" minimum beyond opening. Use pre-manufactured units made of 26 gauge stainless steel.
3. Flashing width: Width required starting flush with outside face of exterior wythe, extending through cavity, rising height required to extend above lintel steel at least 2".
4. Splice end joints by overlapping them 6" and seal with a compatible sealant or metal splice tape.
5. Masonry and concrete back up:
  - a. Surface apply after waterproofing installation specified in accord with manufacturer's installation instructions.
  - b. Fasten to masonry back-up surface at top by embedding in layer of sealant or use a non-corrosive termination bar and fasten it to the backer wall at the top edge of the flashing and seal the top edge with compatible sealant or use a termination clamp, which is embedded in the block back up wall.
6. Stud back up with sheathing:
  - a. Fasten through sheathing into metal studs at top by embedding in layer of sealant and use a non-corrosive termination bar and fasten it to the backer wall at the top edge of the flashing and seal the top edge with a compatible sealant.
  - b. Apply sealant to cover all fastener heads in term bar.
7. Leave ready for certified compatible air barrier installation (installed in another Section) which will lap over top of flashing.
8. Lay flashing in continuous bead of sealant on masonry supporting steel.
9. Use purchased manufacturers preformed end dams. End dams should be sealed down and flashing overlapped onto end dam and sealed down to end dams with US100 sealant. See details on Sheet A0.70.
10. Inside and outside corners: Purchase manufactured corners from manufacturer. Corners should be sealed down and flashing sealed to corners with US100 sealant. See details on Sheet A0.70.
11. Cover flashing within a few days of installation to protect it from damage from the different trades, the environment and falling debris. If flashing is left unprotected and it is punctured, torn, or has loose scrim you should contact the manufacturer for repair instructions.

B. Metal Protection: Where dissimilar metals contact each other, or where metal contacts pressure-treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by flexible flashing manufacturer.

C. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.

### **3.3 INSTALLATION TOLERANCES**

A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on Drawings and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

### **3.4 WASTE MANAGEMENT**

A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.



- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
1. Stainless steel and aluminum.
  2. Plastic Materials and Gaskets.
  3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 07 62 00**

## **SECTION 07 72 00 - ROOF ACCESSORIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Roof hatches with integral guard rails.
  - 2. Preformed flashing sleeves.
- B. Related Requirements:
  - 1. Division 5 Section "Metal Fabrications" for metal vertical ladders and/or ships' ladders for access to roof hatches, and for safety railing and tieoff system on roof.
  - 2. Division 7 Section "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, and miscellaneous sheet metal trim and accessories.
  - 3. Division 7 Section "PVC Roofing" for walkway system on roof.

#### **1.3 COORDINATION**

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of roof accessory.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof accessories.
  - 1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.
- C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
  - 1. Size and location of roof accessories specified in this Section.
  - 2. Method of attaching roof accessories to roof or building structure.
  - 3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
  - 4. Required clearances.
- B. Sample Warranties: For manufacturer's special warranties.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

## 1.7 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta units when tested according to ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Wind-Restraint Performance: As indicated on Structural Drawings.

### 2.2 LADDER ACCESS ROOF HATCH

- A. Basis of Design: Provide E-50TB Roof Hatch by The Bilco Company, New Haven, CT, or approved equivalent.
- B. Furnish and install where indicated on plans metal roof hatch Type E-50TB, size width: 36" (914mm) x length: 36" (914mm). The roof hatch shall be single leaf. The roof hatch shall be pre-assembled from the manufacturer.
- C. Performance characteristics:
  - 1. Cover and curb shall be thermally broken to prevent heat transfer between interior and exterior surfaces.
  - 2. Cover shall be reinforced to support a minimum live load of 40 psf (195kg/m<sup>2</sup>) with a maximum deflection of 1/150th of the span or 20 psf (97kg/m<sup>2</sup>) wind uplift.
  - 3. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
  - 4. Operation of the cover shall not be affected by temperature.
  - 5. Entire hatch shall be weather tight with fully welded corner joints on cover and curb.
- D. Cover: Shall be 11 gauge (2.3mm) aluminum with a 5" (127mm) beaded flange with formed reinforcing members. Interior and exterior surfaces shall be thermally broken to minimize heat transfer and to resist condensation. Cover shall have a heavy extruded EPDM rubber gasket bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.
- E. Cover insulation: Shall be 3" (75mm) thick polyisocyanurate with an R-value = 20.3 (U=0.279 W/m<sup>2</sup>K), fully covered and protected by an 18 gauge (1mm) aluminum liner.
- F. Curb: Shall be 12" (305mm) in height and of 11 gauge (2.3mm) aluminum. Interior and exterior surfaces shall be thermally broken to minimize heat transfer and to resist condensation. The curb shall be formed with a 5-1/2" (140mm) flange with 7/16" (11mm) holes provided for securing to the roof deck. The curb shall be equipped with an integral metal capflashing of the

same gauge and material as the curb, fully welded at the corners, that features the Bil-Clip® flashing system, including stamped tabs, 6" (153mm) on center, to be bent inward to hold single ply roofing membrane securely in place.

- G. Curb insulation: Shall be 3" (75mm) thick polyisocyanurate with an R-value = 20.3 (U=0.279 W/m<sup>2</sup>K).
- H. Lifting mechanisms: Manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe welded to the curb assembly.
- I. Hardware
  - 1. Heavy stainless steel pintle hinges shall be provided
  - 2. Cover shall be equipped with a spring latch with interior and exterior turn handles
  - 3. Roof hatch shall be equipped with interior and exterior padlock hasps.
  - 4. The latch strike shall be a stamped component bolted to the curb assembly.
  - 5. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a 1" (25mm) diameter red vinyl grip handle to permit easy release for closing.
  - 6. Compression spring tubes shall be an anti-corrosive composite material and all other hardware shall be zinc plated and chromate sealed.
  - 7. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space.
- J. Finishes: Factory finish shall be mill finish aluminum.

### **2.3 SHIP'S LADDER ACCESS ROOF HATCH**

- A. Basis-of-Design: Provide Type NB Roof Hatch by The BILCO Company, New Haven, CT, or approved equivalent.
- B. Furnish and install where indicated on plans metal roof hatch Type NB, size width: 30" (762mm) x length: 54" (1372mm). Length denotes hinge side. The roof hatch shall be single leaf. The roof hatch shall be pre-assembled from the manufacturer.
- C. Performance characteristics:
  - 1. Cover shall be reinforced to support a minimum live load of 40 psf (195kg/m<sup>2</sup>) with a maximum deflection of 1/150th of the span or 20 psf (97kg/m<sup>2</sup>) wind uplift.
  - 2. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
  - 3. Operation of the cover shall not be affected by temperature.
  - 4. Entire hatch shall be weather tight with fully welded corner joints on cover and curb.
- D. Cover: Shall be 11 gauge (2.3mm) aluminum with a 3" (76mm) beaded flange with formed reinforcing members. Cover shall have a heavy extruded EPDM rubber gasket that is bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.
- E. Cover insulation: Shall be fiberglass of 1" (25mm) thickness, fully covered and protected by a metal liner 18 gauge (1mm) aluminum.
- F. Curb: Shall be 12" (305mm) in height and of 11 gauge (2.3mm) aluminum. The curb shall be formed with a 3-1/2" (89mm) flange with 7/16" (11mm) holes provided for securing to the roof deck. The curb shall be equipped with an integral metal capflashing of the same gauge and material as the curb, fully welded at the corners, that features the Bil-Clip® flashing system, including stamped tabs, 6" (153mm) on center, to be bent inward to hold single ply roofing membrane securely in place.

- G. Curb insulation: Shall be rigid, high-density fiberboard of 1" (25mm) thickness on outside of curb.
- H. Lifting mechanisms: Manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe welded to the curb assembly.
- I. Hardware
  - 1. Heavy pintle hinges shall be provided
  - 2. Cover shall be equipped with a spring latch with interior and exterior turn handles
  - 3. Roof hatch shall be equipped with interior and exterior padlock hasps.
  - 4. The latch strike shall be a stamped component bolted to the curb assembly.
  - 5. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a 1" (25mm) diameter red vinyl grip handle to permit easy release for closing.
  - 6. Compression spring tubes shall be an anti-corrosive composite material and all other hardware shall be zinc plated and chromate sealed.
  - 7. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space.
- J. Finishes: Factory finish shall be mill finish aluminum.

## **2.4 HATCH RAIL SYSTEM**

- A. Install hatch rail system at both roof hatches specified in this section.
- B. Basis-of-Design: Provide Type Bil-Guard® 2.0 Roof Hatch Railing System by The BILCO Company, New Haven, CT, or approved equivalent.
- C. Furnish and install hatch rail system Models RL2-ETB and RL2-NBTB with their respective hatches. The hatch rail system shall be field assembled and installed (by others) per the manufacturer's instructions.
- D. Performance characteristics:
  - 1. Hatch rail system shall attach to the capflashing of the roof hatch and shall not penetrate any roofing material.
  - 2. Hatch rail system shall satisfy the requirements of OSHA 29 CFR 1910.29 and shall meet OSHA strength requirements with a factor of safety of two.
  - 3. Corrosion resistant construction with a five-year warranty.
  - 4. Hinged gate shall ensure continuous barrier around the roof hatch.
  - 5. Self-closing gate hinge and positive latching system provided with hatch rail system.
- E. Posts and Rails: 1-1/4" (32mm) 6061 T6 schedule 40 aluminum pipe
- F. Finish: Powder coat, in custom color to match Architect's sample.
- G. Hardware: Mounting brackets shall be 3/8" (9mm) thick extruded aluminum. Pivoting post guides with compression fittings and latching mechanism shall be cast aluminum. Self-closing hinges and all fasteners shall be type 316 stainless steel.

## **2.5 PREFORMED FLASHING SLEEVES**

- A. Provide the following vent flashings that are compatible with PVC roofing system specified.
- B. Exhaust Vent Flashing: Double-walled metal flashing sleeve or boot, insulation filled, with integral deck flange, 12 inches high, with removable metal hood and perforated metal collar.
  - 1. Metal: Aluminum sheet, 0.063 inch thick

2. Diameter: To match vent pipe size.
  3. Finish: Manufacturer's standard.
- C. Vent Stack Flashing: Metal flashing sleeve, uninsulated, with integral deck flange.
1. Metal: Aluminum sheet, 0.063 inch thick
  2. Height: 13 inches
  3. Diameter: To match vent pipe size.
  4. Finish: Manufacturer's standard.

## 2.6 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 coating designation.
- B. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A792/A792M, AZ50 coated.
- C. Aluminum Sheet: ASTM B209, manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
- D. Aluminum Extrusions and Tubes: ASTM B221, manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.
- E. Stainless Steel Sheet and Shapes: ASTM A240/A240M or ASTM A666, Type 304.
- F. Steel Shapes: ASTM A36/A36M, hot-dip galvanized according to ASTM A123/A123M unless otherwise indicated.
- G. Steel Tube: ASTM A500/A500M, round tube.
- H. Galvanized-Steel Tube: ASTM A500/A500M, round tube, hot-dip galvanized according to ASTM A123/A123M.
- I. Steel Pipe: ASTM A53/A53M, galvanized.

## 2.7 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 1, thickness as indicated.
- C. Glass-Fiber Board Insulation: ASTM C726, nominal density of 3 lb/cu. ft., thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F, thickness as indicated.
- D. Polyisocyanurate Board Insulation: ASTM C1289, thickness and thermal resistivity as indicated.
- E. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches thick.
- F. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.
- G. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- H. Elastomeric Sealant: ASTM C920, elastomeric polyurethane or silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

- I. Butyl Sealant: ASTM C1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.
- J. Asphalt Roofing Cement: ASTM D4586/D4586M, asbestos free, of consistency required for application.

## **2.8 GENERAL FINISH REQUIREMENTS**

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. General: Install roof accessories according to manufacturer's written instructions.
  - 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
  - 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
  - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
  - 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
  - 1. Coat concealed side of uncoated aluminum or stainless steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
  - 2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
  - 3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- C. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.
- D. Roof-Hatch Installation:
  - 1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.

2. Attach safety railing system to roof-hatch curb.
  3. Attach ladder-assist post according to manufacturer's written instructions.
- E. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.

### **3.3 REPAIR AND CLEANING**

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A780/A780M.
- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Division 09 Section "Painting."
- C. Clean exposed surfaces according to manufacturer's written instructions.
- D. Clean off excess sealants.
- E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

### **3.4 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
1. Aluminum
  2. Plastic Materials and Gaskets
  3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
1. Treated, stained, painted or contaminated wood.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 07 72 00**



## **SECTION 07 81 00 - APPLIED FIREPROOFING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes sprayed fire-resistive materials.
  - 1. Concealed SFRM.
  - 2. Exposed SFRM.
  - 3. Exposed, thin-film intumescent mastic fire-resistive coatings.
  - 4. Spray-applied thermal barriers at spray-applied polyurethane insulation.
- B. Related Sections include the following:
  - 1. Division 05 Section "Structural Steel Framing" for surface conditions required for structural steel receiving SFRM.
  - 2. Division 07 Sections "Penetration Firestopping" and "Joint Firestopping" for fire-resistance-rated firestopping systems.

#### **1.3 DEFINITIONS**

- A. SFRM: Sprayed fire-resistive materials.

#### **1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review products, design ratings, restrained and unrestrained conditions, densities, thicknesses, bond strengths, and other performance requirements.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: Framing plans or schedules, or both, indicating the following:
  - 1. Extent of fireproofing for each construction and fire-resistance rating.
  - 2. Applicable fire-resistance design designations of a qualified testing and inspecting agency acceptable to authorities having jurisdiction.
  - 3. Minimum fireproofing thicknesses needed to achieve required fire-resistance rating of each structural component and assembly.
  - 4. Treatment of fireproofing after application.
- C. Samples: For each exposed product and for each color and texture specified, 4 inches square in size.

#### **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer, manufacturer and testing agency.
- B. Product Certificates: For each type of SFRM and intumescent coating, signed by product manufacturer.
- C. Compatibility and Adhesion Test Reports for Substrate: From fireproofing manufacturer indicating the following:

1. Materials have been tested for bond with substrates.
  2. Materials have been verified by fireproofing manufacturer to be compatible with substrate primers and coatings.
  3. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- D. Letter of Verification of Compatibility for Other Products:
1. Provide letter to verify compatibility of products in this section which come into contact with those listed in the following sections, as shown in the Architectural Drawings:
    - a. Division 07 Section "Fluid-Applied Membrane Air Barriers."
    - b. Division 07 Section "Fluid Applied Insulation Coating."
    - c. Division 07 Section "Pre-Applied Sheet Membrane Waterproofing."
    - d. Division 07 Section "Self-Adhering Sheet Waterproofing."
    - e. Division 07 Section "Thermal Insulation," especially spray applied.
    - f. Division 07 Section "Applied Fireproofing."
    - g. Division 07 Section "Polyvinyl-Chloride (PVC) Roof."
    - h. Division 07 Section "Sheet Metal Flashing & Trim."
    - i. Division 07 Section "Flexible Stainless Steel Flashing."
    - j. Division 08 Section "Glazed Alum Curtain Walls," especially the Extruded Silicone Air and Vapor Barrier Transitions.
  2. Provide additional testing as required to verify compatibility.
- E. Product Test Reports and Research/Evaluation Reports from ICC-ES: Based on evaluation of comprehensive tests performed by a qualified testing agency, for proposed SFRM.
- F. Minutes of preinstallation conference.tev
- G. Field quality-control reports.

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A firm or individual certified, licensed, or otherwise qualified by fireproofing manufacturer as experienced and with sufficient trained staff to install manufacturer's products according to specified requirements. 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. Source Limitations: Obtain SFRM through one source from a single manufacturer.
- C. 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.
- D. 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 fireproofing.
- E. Fire-Test-Response Characteristics: Provide fireproofing with the fire-test-response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify bags containing SFRM with appropriate markings of applicable testing and inspecting agency.
1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" Intertek Testing Services NA Inc.'s "Directory of Listed Products," and FM's "Approval Guide, Building Materials" acceptable to authorities having jurisdiction, for fireproofing serving as direct-applied protection tested per ASTM E 119.
  2. Surface-Burning Characteristics: ASTM E 84.
- F. 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."
- G. Mockups: Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Extent of Mockups: Approximately 10 linear feet of steel beam for each product indicated.
  2. Apply mockups on representative samples of the actual substrate, with texture to simulate actual conditions. The texture on the mockups will be utilized to establish an acceptable range of texture and uniformity of smoothness that shall be maintained in all the actual Work as approved by the Professional
  3. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- H. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to fireproofing including, but not limited to, the following:
1. Review products, exposure conditions, design ratings, restrained and unrestrained conditions, calculations, densities, thicknesses, bond strengths, and other performance requirements.
  2. Review and finalize construction schedule and verify sequencing and coordination requirements.
  3. Review weather predictions, ambient conditions, and proposed temporary protections for fireproofing during and after installation.
  4. Review surface conditions and preparations.
  5. Review field quality-control testing procedures.

## **1.8 FIELD CONDITIONS**

- A. Environmental Limitations: Do not apply fireproofing when ambient or substrate temperature is 40 deg F 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 fireproofing, providing complete air exchanges according to manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fireproofing dries thoroughly.

## **1.9 COORDINATION**

- A. Sequence and coordinate application of fireproofing 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.

## **1.10 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. GCP Applied Technologies.; Monokote Type MK-6 .
    - b. Isolatek International Corp.; Cafco 300.
    - c. Or approved equivalent.
- B. Material Composition: Manufacturer's standard product, as follows:
  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. 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, per ASTM E 605:

- a. Where the referenced fire-resistance design lists a thickness of 1 inch or more, the minimum allowable individual thickness of SFRM is the design thickness minus 0.25 inch.
  - b. Where the referenced fire-resistance design lists a thickness of less than 1 inch but more than 0.375 inch, the minimum allowable individual thickness of SFRM is the greater of 0.375 inch 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..
3. Bond Strength: 150 lbf/sq. ft. minimum per ASTM E 736 based on laboratory testing of 0.75-inch minimum thickness of SFRM.
  4. Compressive Strength: 5.21 lbf/sq. in. minimum per ASTM E 761. Minimum thickness of SFRM tested shall be 0.75 inch and minimum dry density shall be as specified but not less than 15 lb/cu. ft..
  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. in 24 hours per ASTM E 859. For laboratory tests, minimum thickness of SFRM is 0.75 inch, maximum dry density is 15 lb/cu. ft., 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: 0.
    - b. Smoke-Developed Index: 0.
  10. Fungal Resistance: No observed growth on specimens per ASTM G 21.

## 2.2 EXPOSED 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. Exposed Cementitious SFRM:
    - a. GCP Applied Technologies; Monokote Type Z106.
    - b. Isolatek International Corp.; Cafco 400.
    - c. Or approved equivalent.
- B. Material Composition: Manufacturer's standard product, as follows:
  1. Exposed Cementitious SFRM: Factory-mixed, dry, cement aggregate formulation; or chloride-free formulation of gypsum or portland cement binders, additives, and inorganic 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: Values for average and individual densities as required for fire-resistance ratings indicated, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method," but with an average density of not less than 22 lb/cu. ft..
  2. Bond Strength: 434 lbf/sq. ft. minimum per ASTM E 736.
  3. Compressive Strength: 51 lbf/sq. in. minimum per ASTM E 761.
  4. Corrosion Resistance: No evidence of corrosion per ASTM E 937.
  5. Deflection: No cracking, spalling, or delamination per ASTM E 759.
  6. Effect of Impact on Bonding: No cracking, spalling, or delamination per ASTM E 760.
  7. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. per ASTM E 859.
  8. Combustion Characteristics: Passes ASTM E 136.
  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: 0.
  - b. Smoke-Developed Index: 0.
10. Fungal Resistance: No observed growth on specimens per ASTM G 21.

## 2.3 INTUMESCENT FIREPROOFING

- A. Water based Intumescent Coating
- 1. Basis of Design: Provide Firetex FX5120 Water based Intumescent Coating as manufactured by Sherwin-Williams, or an approved equivalent.
    - a. For use on interior exposed structural steel, to provide a smooth paint-like finish for an aesthetic final appearance.
    - b. Comply with indicated fire-resistance design.
  - 2. Thickness: As required for fire-resistance design indicated, measured according to requirements of fire-resistance design.
  - 3. Performance Requirements: Fire-Resistance Design: Indicated on Drawings, tested according to ASTM E 119 and UL 263; testing by a qualified testing agency. Extrapolated thickness is not acceptable.
  - 4. Finish: Flat.
  - 5. Color: White.
- B. Use approved primer on bare steel prior to application of Intumescent Coating.
- 1. Basis of Design: Provide SW ProIndustrial ProCryl Universal Primer
- C. Apply approved topcoat as indicated in Division 09 Section 'Painting.'

## 2.4 SPRAY APPLIED THERMAL BARRIER

- 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. Grace, W.R. & Co. - Conn., Construction Products Div.; Monokote Type Z3306.
  - 2. International Cellulose Corporation, Ure-K Spray Coating
  - 3. Or approved equivalent.
  - 4. Material Composition: Cementitious fire protective coating specifically formulated for application over urethane foam plastic.
- B. 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: Values for average and individual densities as required for fire-resistance ratings indicated, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method," but with an average density of not less than 22 lb/cu. ft..
  - 2. Bond Strength: 434 lbf/sq. ft. minimum per ASTM E 736.
  - 3. Corrosion Resistance: No evidence of corrosion per ASTM E 937.
  - 4. Deflection: No cracking, spalling, or delamination per ASTM E 759.
  - 5. Effect of Impact on Bonding: No cracking, spalling, or delamination per ASTM E 760.
  - 6. Air Erosion: Maximum weight loss of 0.025 g/sq. ft. per ASTM E 859.
  - 7. Combustion Characteristics: Passes ASTM E 136.
  - 8. 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.
    - b. Smoke-Developed Index: 0.
  - 9. Fungal Resistance: No observed growth on specimens per ASTM G 21.
  - 10. Apply in thickness recommended by manufacturer to limit the average temperature rise of the exposed surface to not more than 250 degrees F after 15 minutes of fire exposure, complying with the standard time-temperature curve of ASTM E119.

## 2.5 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that are compatible with fireproofing 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: Primers approved by fireproofing manufacturer and complying with one or both of the following requirements:
  - 1. Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
  - 2. Primer's bond strength in required fire-resistance design complies with specified bond strength for fireproofing and with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests according to ASTM E736.
- C. Bonding Agent: Product approved by fireproofing manufacturer and complying with requirements in UL's "Fire Resistance Directory" or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.
- D. Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required, according to fire-resistance designs indicated and fireproofing manufacturer's written instructions. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive fireproofing.
- 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 fireproofing manufacturer.
- F. Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by fireproofing manufacturer. Include pins and attachment.
- G. Sealer: Transparent-drying, water-dispersible, tinted protective coating recommended in writing by fireproofing manufacturer for each fire-resistance design.
- H. Topcoat: Suitable for application over applied fireproofing; of type recommended in writing by fireproofing manufacturer for each fire-resistance design.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and according to each fire-resistance design.
  - 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. Notify the Professional in writing of anticipated problems using the SFRM systems specified with substrates primed or furnished by others.
  - 6. Do not proceed with the application until unsatisfactory conditions have been corrected.
  - 7. Submit written certification that the conditions and substrates are acceptable.

- B. Verify that concrete work on steel deck is complete before beginning fireproofing work.
- C. Verify that roof construction, installation of rooftop HVAC equipment, and other related work are complete before beginning fireproofing work.
- D. Conduct tests according to fireproofing manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.
- E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. General: Remove accessories, plates, machined surfaces, lighting fixtures, and similar items that are not to be coated, or provide surface-applied protection prior to surface preparation and coating. Remove these items, if necessary, to completely coat the items to be fireproofed. Mask off or otherwise protect items and adjacent surfaces (including the adjacent metal decking) that are not to be fireproofed. Following completion of coating operations in each space or area, reinstall items removed, using workers skilled in the trades involved.
- B. 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.
- C. Schedule cleaning and coating application so dust and other contaminants will not fall on wet, newly coated surfaces.
- D. Surface Preparation: Clean and prepare surfaces to be coated according to the manufacturer's instructions for the particular substrate conditions, and as specified. Surfaces to be coated must be free of oil, grease, dirt, rust, and loose or powdery paint. Comply with the surface preparation requirements specified in Division 09 Section, "Interior Painting".
  1. Touch-up shop applied prime coats which have been damaged, and bare areas. Wire-brush, solvent clean, and touch-up with the same primer as the shop coat.
  2. Bonding Agent: If required, apply bonding agent to surfaces in accordance with the manufacturer's instructions for the type of substrate and application required.
- E. Material Preparation: Carefully mix and prepare materials in accordance with the coating manufacturer's directions.
  1. Stir materials before application to produce a mixture of uniform density, and as required during application. Do not stir surface film into the material. Remove film and strain material before using.
  2. If the manufacturer permits thinning, use only thinners recommended by the manufacturer, and only within recommended limits.
- F. Prime substrates where recommended in writing by SFRM manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive SFRM.
- G. For exposed applications, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of SFRM. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

### **3.3 APPLICATION, GENERAL**

- A. Construct fireproofing assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting fireproofing work.



- B. Comply with fireproofing manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fireproofing; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.
- C. Coordinate application of fireproofing with other construction to minimize need to cut or remove fireproofing.
  - 1. Do not begin applying fireproofing until clips, hangers, supports, sleeves, and other items penetrating fireproofing are in place.
  - 2. Defer installing ducts, piping, and other items that would interfere with applying fireproofing until application of fireproofing is completed.
- D. Metal Decks:
  - 1. Do not apply fireproofing to underside of metal deck substrates until concrete topping, if any, is completed.
  - 2. Do not apply fireproofing to underside of metal roof deck until roofing is completed; prohibit roof traffic during application and drying of fireproofing.
- E. Install auxiliary materials as required, as detailed, and according to fire-resistance design and fireproofing manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by fireproofing manufacturer.
- F. Spray apply fireproofing to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by fireproofing manufacturer.
- G. Extend fireproofing in full thickness over entire area of each substrate to be protected.
- H. Install body of fireproofing in a single course unless otherwise recommended in writing by fireproofing manufacturer.
- I. For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply fireproofing that differs in color from that of encapsulant over which it is applied.
- J. Where sealers are used, apply products that are tinted to differentiate them from fireproofing over which they are applied.
- K. Provide a uniform finish complying with description indicated for each type of fireproofing material and matching finish approved for required mockups.
- L. Cure fireproofing according to fireproofing manufacturer's written instructions.
- M. Do not install enclosing or concealing construction until after fireproofing has been applied, inspected, and tested and corrections have been made to deficient applications.
- N. Finishes: Where indicated, apply fireproofing to produce the following finishes:
  - 1. Manufacturer's Standard Finishes: Finish according to manufacturer's written instructions for each finish selected.
  - 2. Spray-Textured Finish: Finish left as spray applied with no further treatment.
  - 3. Rolled, Spray-Textured Finish: Even finish produced by rolling spray-applied finish with a damp paint roller to remove drippings and excessive roughness.
  - 4. Skip-Troweled Finish: Even leveled surface produced by troweling spray-applied finish to smooth out the texture and neaten edges.
  - 5. Skip-Troweled Finish with Corner Beads: Even, leveled surface produced by troweling spray-applied finish to smooth out the texture, eliminate surface markings, and square off edges.

### **3.4 APPLICATION, CONCEALED SFRM**

- A. 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.
- B. Apply water overspray to concealed sprayed-fiber fire-resistive material as required to obtain designated fire-resistance rating.
- C. Cure concealed SFRM according to product manufacturer's written recommendations.
- D. Apply sealer to concealed SFRM where required.
- E. Apply topcoat to concealed SFRM where indicated.

### **3.5 APPLICATION, EXPOSED SFRM**

- A. Apply exposed 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 indicated.
  - 1. For steel beams and bracing, provide a thickness of not less than 1 inch.
  - 2. For metal floor or roof decks, provide a thickness of not less than 1/2 inch.
- B. Provide a uniform finish complying with description indicated for each type of material and matching Architect's sample or, if none, finish approved for field-erected mockup.
- C. Apply exposed cementitious SFRM to produce the following finish:
  - 1. Skip-troweled finish with leveled surface, smoothed-out texture, and neat edges.
- D. Cure exposed SFRM according to product manufacturer's written recommendations.
- E. Apply tinted topcoat to SFRM where indicated for a painted finish.

### **3.6 APPLICATION, INTUMESCENT COATING**

- A. Construct fireproofing assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, topcoats, finishing, and other materials and procedures affecting fireproofing work.
- B. Comply with fireproofing manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fireproofing; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.
- C. Spray apply fireproofing to maximum extent possible.
- D. Extend fireproofing in full thickness over entire area of each substrate to be protected.
- E. Install body of fireproofing in a single course unless otherwise recommended in writing by fireproofing manufacturer.
- F. Provide a uniform finish complying with description indicated for each type of fireproofing material and matching finish approved for required mockups.
- G. Cure fireproofing according to fireproofing manufacturer's written instructions.
- H. Finishes: Where indicated, apply fireproofing to produce the following finishes:

1. Manufacturer's Standard Finishes: Finish according to manufacturer's written instructions.

### **3.7 FIELD QUALITY CONTROL**

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
  1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
- B. 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 Floor, Roof, and Wall Assemblies: For each 1000-sq. ft. area, or partial area, on each floor, from the average of 4 measurements from a 144-sq. in. sample area, with sample width of not less than 6 inches per ASTM E 605.
  2. 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.
  3. Density for Floors, Roofs, Walls, and Structural Frame Members: At frequency and from sample size indicated for determining thickness of each type of construction and structural framing member, per ASTM E 605 or AWCI Technical Manual 12-A, Section 5.4.5, "Displacement Method."
  4. Bond Strength for Floors, Roofs, Walls, and Structural Framing Members: For each 10,000-sq. ft. 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. minimum per ASTM E 736.
  5. 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.
- C. 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.
- D. 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.

### **3.8 CLEANING, PROTECTING, AND REPAIRING**

- A. Cleaning: 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.
- B. Protect fireproofing, according to advice of manufacturer and Installer, from damage resulting from construction operations or other causes, so fireproofing is without damage or deterioration at time of Substantial Completion.
- C. As installation of other construction proceeds, inspect fireproofing and repair damaged areas and fireproofing removed due to work of other trades.

- D. Repair fireproofing damaged by other work before concealing it with other construction.
- E. Repair fireproofing by reapplying it using same method as original installation or using manufacturer's recommended trowel-applied product.

### **3.9 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 07 81 00**

## **SECTION 07 84 13 - PENETRATION FIRESTOPPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Penetrations in fire-resistance-rated walls.
  - 2. Penetrations in horizontal assemblies.
- B. Related Requirements:
  - 1. Division 07 Section "Joint Firestopping" for joints in or between fire-resistance-rated construction, at exterior curtain-wall/floor intersections, and in smoke barriers.

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Product Schedule: For each penetration firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.
  - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each penetration firestopping system, for tests performed by a qualified testing agency.

#### **1.6 CLOSEOUT SUBMITTALS**

- A. Installer Certificates: From Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

#### **1.7 QUALITY ASSURANCE**

- A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

## **1.8 PROJECT CONDITIONS**

- A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

## **1.9 COORDINATION**

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.
- C. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.
- D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until each installation has been examined by Owner's inspecting agency and building inspector, if required by authorities having jurisdiction.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Fire-Test-Response Characteristics:
  - 1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
  - 2. Test per testing standards referenced in "Penetration Firestopping Systems" Article. Provide rated systems complying with the following requirements:
    - a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.
      - 1) UL in its "Fire Resistance Directory."
      - 2) Intertek Group in its "Directory of Listed Building Products."
      - 3) FM Global in its "Building Materials Approval Guide."

### **2.2 PENETRATION FIRESTOPPING SYSTEMS**

- A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
  - 1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
  - 1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.

2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
  3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.
- D. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E84.
- E. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
1. Permanent forming/damming/backing materials, including the following:
    - a. Slag-wool-fiber or rock-wool-fiber insulation.
    - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
    - c. Fire-rated form board.
    - d. Fillers for sealants.
  2. Substrate primers.
  3. Collars.
  4. Steel sleeves.

### **2.3 FILL MATERIALS**

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

## **2.4 MIXING**

- A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:
  - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
  - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
  - 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape – VERY IMPORTANT!: Use masking tape or other methods to prevent firestopping materials from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping system's seal with substrates.

### **3.3 INSTALLATION**

- A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
  - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- C. Install fill materials by proven techniques to produce the following results:
  - 1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
  - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.



### **3.4 IDENTIFICATION**

- A. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
  - 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
  - 2. Contractor's name, address, and phone number.
  - 3. Designation of applicable testing and inspecting agency.
  - 4. Date of installation.
  - 5. Manufacturer's name.
  - 6. Installer's name.

### **3.5 FIELD QUALITY CONTROL**

- A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2174.
- B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements.
- C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

### **3.6 CLEANING AND PROTECTION**

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

### **3.7 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 07 84 13**

## **SECTION 07 84 43 - JOINT FIRESTOPPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Joints in or between fire-resistance-rated constructions.
  - 2. Joints at exterior curtain-wall/floor intersections.
- B. Related Requirements:
  - 1. Division 07 Section "Penetration Firestopping" for penetrations in fire-resistance-rated walls, horizontal assemblies, and smoke barriers.
  - 2. Division 09 Section "Non-Structural Metal Framing" for firestop tracks for metal-framed partition heads.

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Product Schedule: For each joint firestopping system. Include location, illustration of firestopping system, and design designation of qualified testing agency.
  - 1. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each joint firestopping system, for tests performed by a qualified testing agency.

#### **1.6 CLOSEOUT SUBMITTALS**

- A. Installer Certificates: From Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

#### **1.7 QUALITY ASSURANCE**

- A. Installer Qualifications: A firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," or been evaluated by UL and found to comply with UL's "Qualified Firestop Contractor Program Requirements."

## **1.8 PROJECT CONDITIONS**

- A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

## **1.9 COORDINATION**

- A. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of joints to accommodate joint firestopping systems.
- C. Notify Owner's testing agency at least seven days in advance of fire-resistive joint system installations; confirm dates and times on day preceding each series of installations.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Fire-Test-Response Characteristics:
  - 1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
  - 2. Test per testing standards referenced in "Joint Firestopping Systems" Article. Provide rated systems complying with the following requirements:
    - a. Joint firestopping systems shall bear classification marking of a qualified testing agency.
      - 1) UL in its "Fire Resistance Directory."
      - 2) Intertek Group in its "Directory of Listed Building Products."

### **2.2 JOINT FIRESTOPPING SYSTEMS**

- A. Where required, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assemblies in or between which fire-resistive joint systems are installed. Fire-resistive joint systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases.
- B. Joints in or between Fire-Resistance-Rated Construction: Provide fire-resistive joint systems with ratings determined per ASTM E 1966 or UL 2079:
  - 1. Joints include those installed in or between fire-resistance-rated walls, floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies.
  - 2. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of construction they will join.
  - 3. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. A/D Fire Protection Systems Inc.
    - b. CEMCO.
    - c. Fire Trak Corp.
    - d. Grace Construction Products.
    - e. Hilti, Inc.
    - f. Johns Manville.
    - g. Nelson Firestop Products.
    - h. NUCO Inc.

- i. Passive Fire Protection Partners.
  - j. RectorSeal Corporation.
  - k. Specified Technologies Inc.
  - l. 3M Fire Protection Products.
  - m. Tremco, Inc.; Tremco Fire Protection Systems Group.
  - n. USG Corporation.
  - o. Or approved equivalent.
- C. Joints at Exterior Curtain-Wall/Floor Intersections: Provide fire-resistive joint systems with rating determined by ASTM E 119 based on testing at a positive pressure differential of 0.01-inch wg or ASTM E 2307.
- 1. Fire-Resistance Rating: Equal to or exceeding the fire-resistance rating of the floor assembly.
  - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the following or an approved equivalent:
    - a. A/D Fire Protection Systems Inc.
    - b. Grace Construction Products.
    - c. Hilti, Inc.
    - d. Johns Manville.
    - e. Nelson Firestop Products.
    - f. NUCO Inc.
    - g. Passive Fire Protection Partners.
    - h. RectorSeal Corporation.
    - i. Specified Technologies Inc.
    - j. 3M Fire Protection Products.
    - k. Thermafiber, Inc.
    - l. Tremco, Inc.; Tremco Fire Protection Systems Group.
    - m. USG Corporation.
    - n. Or approved equivalent.
- D. Exposed Fire-Resistive Joint Systems: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. Accessories: Provide components of fire-resistive joint systems, including primers and forming materials, that are needed to install fill materials and to maintain ratings required. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing agency for systems indicated.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Surface Cleaning: Before installing fire-resistive joint systems, clean joints immediately to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
  - 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire-resistive rating.
  - 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
  - 3. Remove laitance and form-release agents from concrete.

- B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape – VERY IMPORTANT!: Use masking tape or other methods to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

### **3.3 INSTALLATION**

- A. General: Install fire-resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
  - 1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire-resistive joint system.
- C. Install elastomeric fill materials for fire-resistive joint systems by proven techniques to produce the following results:
  - 1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire-resistance ratings indicated.
  - 2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
  - 3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

### **3.4 IDENTIFICATION**

- A. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
  - 1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
  - 2. Contractor's name, address, and phone number.
  - 3. Designation of applicable testing agency.
  - 4. Date of installation.
  - 5. Manufacturer's name.
  - 6. Installer's name.

### **3.5 FIELD QUALITY CONTROL**

- A. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E2393.
- B. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.
- C. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

### **3.6 CLEANING AND PROTECTION**

- A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.
- B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

### **3.7 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 07 84 43**

## **SECTION 07 92 00 - JOINT SEALANTS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  1. Silicone joint sealants.
  2. Urethane joint sealants.
  3. Silyl-terminated polyether joint sealants.
  4. Mildew-resistant joint sealants.
  5. Butyl joint sealants.
  6. Latex joint sealants.
  7. Pre-compressed, self-expanding foam joint sealants.
- B. Related Requirements:
  1. Division 04 Section "Stone Cladding" for sealants used in slate veneer.
  2. Division 09 Section "Cork Flooring" for sealants recommended by manufacturer to be used with that material.
  3. Division 09 Section "Linoleum Flooring" for sealants recommended by manufacturer to be used with that material.
  4. Division 09 Section "Gypsum Board" for acoustical sealant.

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each joint-sealant product.
- B. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch-wide joints formed between two 6-inch-long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint-Sealant Schedule: Include the following information:
  1. Joint-sealant application, joint location, and designation.
  2. Joint-sealant manufacturer and product name.
  3. Joint-sealant formulation.
  4. Joint-sealant color.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified testing agency.
- B. Product Test Reports: For each kind of joint sealant, for tests performed by a qualified testing agency.

- C. Preconstruction Laboratory Test Schedule: Include the following information for each joint sealant and substrate material to be tested:
  1. Joint-sealant location and designation.
  2. Manufacturer and product name.
  3. Type of substrate material.
  4. Proposed test.
  5. Number of samples required.
- D. Preconstruction Laboratory Test Reports: From sealant manufacturer, indicating the following:
  1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
  2. Interpretation of test results and written recommendations for primers and substrate preparation are needed for adhesion.
- E. Preconstruction Field-Adhesion-Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- F. Field-Adhesion-Test Reports: For each sealant application tested.
- G. Sample Warranties: For special warranties.

## **1.6 QUALITY ASSURANCE**

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Product Testing: Test joint sealants using a qualified testing agency.
  1. Testing Agency Qualifications: Qualified according to ASTM C1021 to conduct the testing indicated.
- C. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.

## **1.7 PRECONSTRUCTION TESTING**

- A. Preconstruction Laboratory Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
  1. Adhesion Testing: Use ASTM C794 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
  2. Compatibility Testing: Use ASTM C1087 to determine sealant compatibility when in contact with glazing and gasket materials.
  3. Stain Testing: Use ASTM C1248 to determine stain potential of sealant when in contact with stone and masonry substrates.
  4. Submit manufacturer's recommended number of pieces of each type of material, including joint substrates, joint-sealant backings, and miscellaneous materials.
  5. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
  6. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures, including use of specially formulated primers.
  7. Testing will not be required if joint-sealant manufacturers submit data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, staining of, and compatibility with joint substrates and other materials matching those submitted.
- B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
  1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.



2. Conduct field tests for each kind of sealant and joint substrate.
3. Notify Architect seven days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
  - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1.1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
    - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

## **1.8 FIELD CONDITIONS**

- A. Do not proceed with installation of joint sealants under the following conditions:
  1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
  2. When joint substrates are wet.
  3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
  4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

## **1.9 WARRANTY**

- A. Special Installer's Warranty: Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Manufacturer's Warranty: Manufacturer agrees to furnish joint sealants to repair or replace those joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  1. Warranty Period: Five years from date of Substantial Completion.
- C. Special warranties specified in this article exclude deterioration or failure of joint sealants from the following:
  1. Movement of the structure caused by stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
  2. Disintegration of joint substrates from causes exceeding design specifications.
  3. Mechanical damage caused by individuals, tools, or other outside agents.
  4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

## **PART 2 - PRODUCTS**

### **2.1 JOINT SEALANTS, 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 joint-sealant manufacturer, based on testing and field experience.

- B. **VOC Content:** Sealants and sealant primers shall comply with the following:
1. Architectural sealants shall have a VOC content of 250 g/L or less.
  2. Sealants and sealant primers for nonporous substrates shall have a VOC content of 250 g/L or less.
  3. Sealants and sealant primers for nonporous substrates shall have a VOC content of 775 g/L or less.
- C. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

## 2.2 MANUFACTURERS

- A. Basis of Design: Provide sealants of the types listed below as manufactured by Sherman Williams, or approved equivalent.

## 2.3 SILICONE JOINT SEALANTS

- A. Silicone, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
1. Sherwin Williams, White Lightning Silicone Ultra Sealant, or approved equivalent.
- B. Silicone, Acid Curing, S, NS, 25, NT: Single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant: ASTM C 920, Type S, Grade NS, Class 25, Use NT.
1. Sherwin Williams, White Lightning Silicone Rubber All Purpose Sealant, or approved equivalent.

## 2.4 URETHANE JOINT SEALANTS

- A. Urethane, S, NS, 35, NT: Single-component, nonsag, nontraffic-use, plus 35 percent and minus 35 percent movement capability, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 35, Use NT.
1. Sherwin Williams Loxon S1 Smooth Polyurethane Sealant, or approved equivalent.
- B. Urethane, S, NS, 35, T, NT: Single-component, nonsag, plus 35 percent and minus 35 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade NS, Class 35, Uses T and NT.
1. Sherwin Williams Loxon S1 Smooth Polyurethane Sealant, or approved equivalent.
- C. Urethane, S, P, 35, T, NT: Single-component, pourable, plus 35 percent and minus 35 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade P, Class 35, Uses T and NT.
1. Sherwin Williams Loxon SL1 Polyurethane Sealant, or approved equivalent.
- D. Urethane, M, NS, 25, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 25, Use NT.
1. Sherwin Williams Loxox NS2 Multi-Component Polyurethane Sealant, or approved equivalent.
- E. Urethane, M, NS, 25, T, NT: Multicomponent, nonsag, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade NS, Class 25, Uses T and NT.
1. Sherwin Williams Loxon NS2 Multi-Component Polyurethane Sealant, or approved equivalent.

- F. Urethane, M, P, 25, T, NT: Multicomponent, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type M, Grade P, Class 25, Uses T and NT.
  - 1. Sherwin Williams Loxon SL2 Multi-Component Polyurethane Sealant, or approved equivalent.

## **2.5 SILYL-TERMINATED POLYETHER (STPE) JOINT SEALANTS**

- A. STPE, S, NS, 50, NT: Single-component, nonsag, plus 50 percent and minus 50 percent movement capability, nontraffic-use, silyl-terminated polyether joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT.
  - 1. Sherwin Williams Loxon H1 Hybrid Polyurethane Sealant, or approved equivalent.
- B. STPE, S, NS, 35, NT: Single-component, nonsag, plus 35 percent and minus 35 percent movement capability, nontraffic-use, silyl-terminated polyether joint sealant; ASTM C 920, Type S, Grade NS, Class 35, Use NT.
  - 1. Sherwin Williams, White Lightning Paintable Silicone All Purpose Sealant, or approved equivalent.

## **2.6 MILDEW-RESISTANT JOINT SEALANTS**

- A. Mildew-Resistant Joint Sealants: Formulated for prolonged exposure to humidity with fungicide to prevent mold and mildew growth.
- B. Silicone, Mildew Resistant, Acid Curing, S, NS, 25, NT: Mildew-resistant, single-component, nonsag, plus 25 percent and minus 25 percent movement capability, nontraffic-use, acid-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT.
  - 1. Sherwin Williams, White Lightning Silicone Rubber All Purpose Sealant, or approved equivalent.

## **2.7 BUTYL JOINT SEALANTS**

- A. Butyl-Rubber-Based Joint Sealants: ASTM C 1311.
  - 1. Sherwin Williams, White Lightning Butyl Rubber Caulk, or approved equivalent.

## **2.8 LATEX JOINT SEALANTS**

- A. Acrylic Latex: Acrylic latex or siliconized acrylic latex, ASTM C 834, Type OP, Grade NF.
  - 1. Sherwin Williams Sher-Max Urethanized Elastomeric Sealant, or approved equivalent.

## **2.9 PRE-COMPRESSED, SELF-EXPANDING FOAM JOINT SEALANTS**

- A. General: Pre-compressed, self-expanding foam joint sealants shall be of type engineered to perform as a highly flexible, weather-tight, primary seal against rain, wind, dust and sound.
- B. Basis of Design Product: Provide "Willseal 150" Pre-compressed, self-expanding foam joint sealants as manufactured by Willseal LLC, or an approved equivalent product that meets the performance, durability, physical property and warranty requirements of the named basis of design product.
- C. Composition: Pre-compressed, self-expanding foam joint sealants shall be comprised of three elements, including a super-resilient micro-cell polyurethane foam, an impregnation of flame retardant, hydrophobic UV stabilized acrylic emulsion, and a pressure-sensitive adhesive with embedded scrim to prevent stretching or pulling during installation.
- D. Performance Criteria:
  - 1. Shall be waterproof to a wind driven rain at 16.1 psf (90mph).

E. Physical Properties:

**TYPICAL PHYSICAL PROPERTIES**

PROPERTY	TEST METHOD	VALUE
Color		Black/Gray (On Request)
Thermal Conductivity	ASTM C 518	0.05 W/m.°C
Thermal Resistance	ASTM C 518	3.3 hr-°F-ft <sup>2</sup> /Btu
Tensile Strength	ASTM D 3574	21 psi min.
Temperature Stability Range		- 40°F to 212°F
Elongation	ASTM D 3574	120% +/-20%
Compression Set	ASTM D 3574	2.5% max
Staining and Bleeding	DIN 18 542	Meets DIN requirements
Resistance to UV and Moisture	DIN 18 542	Meets DIN requirements
Shelf Life		1 year
Water Resistance	ASTM E 331 ASTM E 547	12 psf 12 psf
Flammability Fire Testing	UL94VO ASTM E 84	Self Extinguishing Flame Spread: 0, Smoke Developed: 5
Compatibility with conventional construction materials	DIN 52 423	No signs of corrosion were observed on zinc, steel, galvanized steel, aluminium and copper; no adverse effects with concrete, aerated concrete, brick, some natural stone, PVC, Plexiglass and wood; for other materials consult Willseal
Ideal Storage Temperature		68°F
Performance Guarantee		10 year warranty <sup>2</sup> on performance

1 Attachment method of Willseal 150 was in a single joint compressed to 50 % of original foam thickness. Joint material was constructed of calcium silicate board and is representative of field installation of the product.

2 Due to the conditions set by Willseal, certain restrictions apply. Inquire with Willseal for details.

F. Sizes: As indicated on Drawings and as recommended by manufacturer based on application and joint sizes.

G. Colors: As selected by Architect from manufacturer’s full range of standard and optional colors

**2.10 JOINT-SEALANT BACKING**

A. Sealant Backing Material, General: Nonstaining; compatible with joint substrates, sealants, primers, and other joint fillers; and approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

B. Cylindrical Sealant Backings: ASTM C1330, Type C (closed-cell material with a surface skin), Type O (open-cell material), Type B (bicellular material with a surface skin), or any of the preceding types, 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. 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. Provide self-adhesive tape where applicable.

## **2.11 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.
  - 1. Sherwin Williams Loxon Porous Surface Primer (for use with low modulus hybrid sealant on porous surfaces).
  - 2. Sherwin Williams Loxon Quick Dry Solvent based Primer.
  - 3. Or approved equivalent.
- 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 EXAMINATION**

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
  - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
  - 2. Clean porous joint substrate surfaces by brushing, grinding, 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. Porous joint substrates include the following:
    - a. Concrete.
    - b. Masonry.
    - c. Unglazed surfaces of ceramic tile.
  - 3. Remove laitance and form-release agents from concrete.
  - 4. Clean nonporous joint substrate surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants. Nonporous joint substrates include the following:
    - a. Metal.
    - b. Primed and/or painted steel.
    - c. Primed and/or painted aluminum.
    - d. Fluoropolymer coated aluminum.
    - e. Glass.
    - f. Porcelain enamel.

- g. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended by joint-sealant manufacturer or as indicated by 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 or primer 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.

### **3.3 INSTALLATION OF JOINT SEALANTS**

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind 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 in subparagraphs 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 profile per Figure 8A in ASTM C1193 unless otherwise indicated.
  - 4. Provide flush joint profile where indicated according to Figure 8B in ASTM C1193.
  - 5. Provide recessed joint configuration of recess depth and where indicated according to Figure 8C in ASTM C1193.
    - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.

### **3.4 FIELD QUALITY CONTROL**

- A. Field-Adhesion Testing: Field test joint-sealant adhesion to joint substrates as follows:
  - 1. Extent of Testing: Test completed and cured sealant joints as follows:
    - a. Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.

- b. Perform one test for each 1000 feet of joint length thereafter or one test per each floor per elevation.
  - 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.
    - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
  - 3. Inspect tested joints and report on the following:
    - a. Whether sealants filled joint cavities and are free of voids.
    - b. Whether sealant dimensions and configurations comply with specified requirements.
    - c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field-adhesion hand-pull test criteria.
  - 4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
  - 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- B. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

### **3.5 CLEANING**

- A. 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.

### **3.6 PROTECTION**

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

### **3.7 JOINT-SEALANT SCHEDULE**

- A. Joint-Sealant Application: Exterior joints in horizontal traffic surfaces.
  - 1. Joint Locations:
    - a. Control and expansion joints in brick pavers.
    - b. Isolation and contraction joints in cast-in-place concrete slabs.
    - c. Joints between plant-precast architectural concrete paving units.
    - d. Joints in stone paving units, including steps.
    - e. Joints between concrete and asphalt.
    - f. Joints between different materials listed above.
    - g. Other joints as indicated on Drawings.
  - 2. Joint Sealant:
    - a. Openings equal to or less than 1 1/2": Sherwin Williams Loxon SL1 Polyurethane Sealant or Sherwin Williams Loxon H1 Low Modulus Hybrid Sealant

- b. Openings equal to or less than 3": Sherwin Williams Loxon SL2 Polyurethane Sealant
    - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- B. Joint-Sealant Application: Exterior joints in vertical surfaces.
  - 1. Joint Locations:
    - a. Construction joints in cast-in-place concrete.
    - b. Control and expansion joints in unit masonry.
    - c. Joints in dimension stone cladding.
    - d. Joints between metal panels.
    - e. Joints between different materials listed above.
    - f. Perimeter joints between materials listed above and frames of doors, curtain wall and louvers.
    - g. Control and expansion joints in ceilings and other overhead surfaces.
    - h. Other joints as indicated on Drawings.
  - 2. Joint Sealant:
    - a. Openings equal to or less than 1 ½": Sherwin Williams Loxon S1 Polyurethane Sealant or Sherwin Williams Loxon H1 Low Modulus Hybrid Sealant
    - b. Openings equal to or less than 3": Sherwin Williams Loxon S2 Polyurethane Sealant
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
  - 1. Joint Locations:
    - a. Isolation joints in cast-in-place concrete slabs.
    - b. Control and expansion joints in stone flooring.
    - c. Control and expansion joints in brick flooring.
    - d. Control and expansion joints in terrazzo flooring.
    - e. Other joints as indicated on Drawings.
  - 2. Joint Sealant:
    - a. Openings equal to or less than 1 ½": Sherwin Williams Loxon SL1 Polyurethane Sealant
    - b. Openings equal to or less than 3": Sherwin Williams Loxon SL2 Polyurethane Sealant
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Joint-Sealant Application: Interior joints in vertical surfaces.
  - 1. Joint Locations:
    - a. Control and expansion joints on exposed interior surfaces of exterior walls.
    - b. Tile control and expansion joints.
    - c. Vertical joints on exposed surfaces of unit masonry concrete walls and partitions.
    - d. Other joints as indicated on Drawings.
  - 2. Joint Sealant:
    - a. Openings equal to or less than 1 ½": Sherwin Williams Loxon S1 Polyurethane Sealant
    - b. Openings equal to or less than 3": Sherwin Williams Loxon S2 Polyurethane Sealant
    - OR--
    - c. Sherwin Williams Loxon H1 Low Modulus Hybrid Sealant
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.
  - 1. Joint Locations:
    - a. Control joints on exposed interior surfaces of exterior walls.
    - b. GWB, painted wood, plastic laminate casework.
    - c. Perimeter joints between interior wall surfaces and frames of interior doors windows and elevator entrances.



- d. Other joints as indicated on Drawings.
    - 2. Joint Sealant:
      - a. Sherwin Williams PowerHouse Siliconized Acrylic Latex Caulk
    - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
  - F. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
    - 1. Joint Locations:
      - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
      - b. Tile control and expansion joints where indicated.
      - c. Other joints as indicated on Drawings.
    - 2. Joint Sealant: Sherwin Williams White Lightning Silicone Rubber All Purpose Sealant
    - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
  - G. Joint-Sealant Application: Concealed mastics.
    - 1. Joint Locations:
      - a. Aluminum thresholds.
      - b. Sill plates.
      - c. Other joints as indicated on Drawings.
    - 2. Joint Sealant: Sherwin Williams White Lightning Butyl Rubber Caulk
    - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

### **3.8 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 07 92 00**

## 08 11 13 – HOLLOW METAL DOORS & FRAMES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
1. Hollow metal doors and frames.
  2. Light frames and glazing installed in hollow metal doors.
  3. Louvers installed in hollow metal doors.
- B. Related Sections:
1. Division 04 Section "Unit Masonry" for embedding anchors for hollow metal work into masonry construction.
  2. Division 08 Section "Glazing" for glass view panels in hollow metal doors.
  3. Division 08 Section "Door Hardware".
  4. Division 09 Sections "Painting" for field painting hollow metal doors and frames.
  5. Division 26 "Electrical" Sections for electrical connections including conduit and wiring for door controls and operators installed on frames with factory installed electrical knock out boxes.
  6. Division 28 Section "Access Control" for access control devices installed at door openings and provided as part of a security access control system.
- C. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
1. ANSI/SDI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.
  2. ANSI/SDI A250.4 - Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frames, Frames Anchors and Hardware Reinforcing.
  3. ANSI/SDI A250.6 - Recommended Practice for Hardware Reinforcing on Standard Steel Doors and Frames.
  4. ANSI/SDI A250.10 - Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
  5. ANSI/SDI A250.11 - Recommended Erection Instructions for Steel Frames.
  6. ASTM A1008 - Standard Specification for Steel Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
  7. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  8. ASTM A924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
  9. ASTM C 1363 - Standard Test Method for Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
  10. ANSI/BHMA A156.115 - Hardware Preparation in Steel Doors and Frames.
  11. ANSI/SDI 122 - Installation and Troubleshooting Guide for Standard Steel Doors and Frames.
  12. ANSI/NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.
  13. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies; National Fire Protection Association.
  14. UL 10C - Positive Pressure Fire Tests of Door Assemblies.
  15. UL 1784 - Standard for Air Leakage Tests of Door Assemblies.

### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.
- B. Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the steel door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.
- C. Shop Drawings: Include the following:
  - 1. Elevations of each door design.
  - 2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
  - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
  - 4. Locations of reinforcement and preparations for hardware.
  - 5. Details of anchorages, joints, field splices, and connections.
  - 6. Details of vision lites and door louvers.
  - 7. Details of accessories.
  - 8. Details of moldings, removable stops, and glazing.
  - 9. Details of conduit and preparations for power, signal, and control systems.
- D. Samples for Verification:
  - 1. Samples are only required by request of the architect and for manufacturers that are not current members of the Steel Door Institute.

### 1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal doors and frames through one source from a single manufacturer wherever possible.
- B. Quality Standard: In addition to requirements specified, furnish SDI-Certified manufacturer products that comply with ANSI/SDI A250.8, latest edition, "Recommended Specifications for Standard Steel Doors and Frames".
- C. 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 UL10C (neutral pressure at 40" above sill) or UL 10C.
  - 1. Temperature-Rise Limit: Where indicated and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F above ambient after 30 minutes of standard fire-test exposure.
- D. Energy Efficient Exterior Openings: Comply with minimum thermal ratings, based on ASTM C1363. Openings to be fabricated and tested as fully operable, thermal insulating door and frame assemblies.
  - 1. Thermal Performance (Exterior Openings): Independent testing laboratory certification for exterior door assemblies being tested in accordance with ASTM C1363 and meet or exceed the following requirements:
    - a. Door Assembly Operable U-Factor and R-Value Ratings: U-Factor 0.29, R-Value 3.4, including insulated door, thermal-break frame and threshold.
  - 2. Air Infiltration (Exterior Openings): Independent testing laboratory certification for exterior door assemblies being tested in accordance with ASTM E283 to meet or exceed the following requirements:
    - a. Rate of leakage of the door assembly shall not exceed 0.25 cfm per square foot of static differential air pressure of 1.567 psf (equivalent to 25 mph wind velocity).
- E. Pre-Submittal Conference: Conduct conference with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for installing hollow metal

doors and frames and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.

### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver hollow metal work palletized, wrapped, or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch-high wood blocking. Do not store in a manner that traps excess humidity.
  - 1. Provide minimum 1/4-inch space between each stacked door to permit air circulation. Door and frames to be stacked in a vertical upright position.

### **1.6 PROJECT CONDITIONS**

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

### **1.7 COORDINATION**

- A. Coordinate installation of anchorages for hollow metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.

### **1.8 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.
- B. Warranty includes installation and finishing that may be required due to repair or replacement of defective doors.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide steel doors and frames from a SDI Certified manufacturer listed below, or approved equivalent:
  - 1. CECO Door Products (C).
  - 2. Curries Company (CU).
  - 3. Or approved equivalent.

### **2.2 MATERIALS**

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Metallic-Coated Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60 metallic coating.
- C. Frame Anchors: ASTM A 653/A 653M, Commercial Steel (CS), Commercial Steel (CS), Type B; with minimum G60 metallic coating.

## 2.3 HOLLOW METAL DOORS

- A. General: Provide 1-3/4 inch doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces unless otherwise indicated. Comply with ANSI/SDI A250.8 and ANSI/NAAMM HMMA 867.
- B. Exterior Doors (Energy Efficient): Face sheets fabricated of commercial quality hot-dipped zinc coated steel that complies with ASTM A924 A60. Provide doors complying with requirements indicated below by referencing ANSI/SDI A250.8 for level and model, ANSI/SDI A250.4 for physical performance level, and HMMA 867 for door construction.
1. Design: Flush panel.
  2. Core Construction: Foamed in place polyurethane and steel stiffened laminated core with no stiffener face welds, in compliance with HMMA 867 "Laminated Core".
    - a. Provide 22 gauge steel stiffeners at 6 inches on-center internally welded at 5" on-center to integral core assembly, foamed in place polyurethane core chemically bonded to all interior surfaces. No stiffener face welding is permitted.
    - b. Thermal properties to rate at a fully operable minimum U-Factor 0.29 and R-Value 3.4, including insulated door, thermal-break frame and threshold.
    - c. Kerf Type Frames: Thermal properties to rate at a fully operable minimum U-Factor 0.36 and R-Value 2.7, including insulated door, kerf type frame, and threshold.
  3. Level/Model: Level 3 and Physical Performance Level A (Extra Heavy Duty), Minimum 16 gauge (0.053 inch - 1.3-mm) thick steel, Model 2.
  4. Vertical Edges: Vertical edges to be mechanically interlocked with hairline seam. Beveled Lock Edge, 1/8 inch in 2 inches.
  5. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet. Doors with an inverted top channel to include a steel closure channel, screw attached, with the web of the channel flush with the face sheets of the door. Plastic or composite channel fillers are not acceptable.
  6. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9".
  7. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
- C. Interior Doors: Face sheets fabricated of commercial quality cold rolled steel that complies with ASTM A 1008/A 1008M. 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. Design: Flush panel.
  2. Core Construction: Manufacturer's standard vertical steel-stiffener core. Minimum 22 gauge steel-stiffeners at 6 inches on-center construction attached by spot welds spaced not more than 5" on centers. Spaces between stiffeners filled with fiberglass insulation (minimum density 0.8#/cubic ft.).
    - a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
  3. Level/Model: Level 2 and Physical Performance Level B (Heavy Duty), Minimum 18 gauge (0.042-inch - 1.0-mm) thick steel, Model 2.
  4. Vertical Edges: Vertical edges to have the face sheets joined by a continuous weld extending the full height of the door. Welds are to be ground, filled and dressed smooth. Beveled Lock Edge, 1/8 inch in 2 inches.
  5. Top and Bottom Edges: Reinforce tops and bottoms of doors with a continuous steel channel not less than 16 gauge, extending the full width of the door and welded to the face sheet.
  6. Hinge Reinforcement: Minimum 7 gauge (3/16") plate 1-1/4" x 9" or minimum 14 gauge continuous channel with pierced holes, drilled and tapped.
  7. Hardware Reinforcements: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.

- D. Manufacturers Basis of Design: Provide product listed below, or approved equivalent.
  - 1. Interior - CECO Door Products (C) Steel-Stiffened - Medallion Series.
  - 2. Exterior - CECO Door Products (C) Energy Efficient - Trio-E Series.

## 2.4 HOLLOW METAL FRAMES

- A. General: Comply with ANSI/SDI A250.8 and with details indicated for type and profile.
- B. Thermal Break Frames: Subject to the same compliance standards and requirements as standard hollow metal frames. Tested for thermal performance in accordance with NFRC 102, and resistance to air infiltration in accordance with NFRC 400. Where indicated provide thermally broken frame profiles available for use in both masonry and drywall construction. Fabricate with 1/16" positive thermal break and integral vinyl weatherstripping.
- C. Exterior Frames: Fabricated of hot-dipped zinc coated steel that complies with ASTM A 653/A 653M, Coating Designation A60.
  - 1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
  - 2. Frames: Minimum 14 gauge (0.067-inch -thick steel sheet.
  - 3. Manufacturers Basis of Design: Provide product listed below, or approved equivalent.
    - a. CECO Door Products (C) – Thermal Break TQB Series.
- D. Interior Frames: Fabricated from cold-rolled steel sheet that complies with ASTM A 1008/A 1008M.
  - 1. Fabricate frames with mitered or coped corners. Profile as indicated on drawings.
  - 2. Frames: Minimum 16 gauge (0.053-inch -thick steel sheet.
  - 3. Manufacturers Basis of Design: Provide products listed below, or approved equivalent.
    - a. CECO Door Products (C) - BQ Series.
    - b. CECO Door Products (C) - SQ Series.
- E. Fire rated frames: Fabricate frames in accordance with NFPA 80, listed and labeled by a qualified testing agency, for fire-protection ratings indicated.
- F. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 Table 4 with reinforcement plates from same material as frames.

## 2.5 FRAME ANCHORS

- A. Jamb Anchors:
  - 1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, formed from A60 metallic coated material, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
  - 2. Stud Wall Type: Designed to engage stud and not less than 0.042 inch thick.
- B. Floor Anchors: Floor anchors to be provided at each jamb, formed from A60 metallic coated material, not less than 0.042 inches thick.
- C. Mortar Guards: Formed from same material as frames, not less than 0.016 inches thick.

## 2.6 LIGHT OPENINGS AND GLAZING

- A. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints at fabricator's shop. Fixed and removable stops to allow multiple glazed lites each to be removed independently. Coordinate frame rabbet widths between fixed and removable stops with the type of glazing and installation indicated.

- B. Moldings for Glazed Lites in Doors and Loose Stops for Glazed Lites in Frames: Minimum 20 gauge thick, fabricated from same material as door face sheet in which they are installed.

## 2.7 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Grout Guards: Formed from same material as frames, not less than 0.016 inches thick.

## 2.8 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. When shipping limitations so dictate, frames for large openings are to be fabricated in sections for splicing or splining in the field by others.
- B. Tolerances: Fabricate hollow metal work to tolerances indicated in ANSI/SDI A250.8.
- C. Hollow Metal Doors:
  - 1. Exterior Doors: Provide optional weep-hole openings in bottom of exterior doors to permit moisture to escape where specified.
  - 2. Glazed Lites: Factory cut openings in doors with applied trim or kits to fit. Factory install glazing where indicated.
  - 3. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge strap for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".
  - 4. Electrical Raceways: Provide hollow metal doors to receive electrified hardware with concealed wiring harness and standardized Molex™ plug connectors on both ends to accommodate up to twelve wires. Coordinate connectors on end of the wiring harness to plug directly into the electrified hardware and the through-wire transfer hardware or wiring harness specified in hardware sets in Division 08 Sections "Door Hardware" and "Access Control Hardware". Wire nut connections are not acceptable.
- D. Hollow Metal Frames:
  - 1. Shipping Limitations: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
  - 2. Welded Frames: Weld joints continuously through full throat width of frames, including rabbets, soffits, and stops; grind, fill, dress, and make smooth, flush, and invisible.
    - a. Welded frames are to be provided with two steel spreaders temporarily attached to the bottom of both jambs to serve as a brace during shipping and handling. Spreader bars are for bracing only and are not to be used to size the frame opening.
  - 3. Equal Rabbet Frames: Provide frames with equal rabbet dimensions unless glazing and removable stops require wider dimensions on glass side of frame.
  - 4. High Frequency Hinge Reinforcement: Provide high frequency hinge reinforcements at door openings 48-inches and wider with mortise butt type hinges at top hinge locations.
  - 5. Continuous Hinge Reinforcement: Provide welded continuous 12 gauge straps for continuous hinges specified in hardware sets in Division 08 Section "Door Hardware".
  - 6. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated for removable stops, provide security screws at exterior locations.
  - 7. Electrical Thru-Wiring: Provide hollow metal frames receiving electrified hardware with loose wiring harness (not attached to open throat components or installed in closed mullion tubes) and standardized Molex™ plug connectors on one end to accommodate up to twelve wires. Coordinate connectors on end of the wiring harness to plug directly into the electric through-wire transfer hardware or wiring harness specified in hardware sets in Division 08 Sections "Door Hardware" and "Access Control Hardware".

8. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
  9. Jamb Anchors: Provide number and spacing of anchors as follows:
    - a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
      - 1) Two anchors per jamb up to 60 inches high.
      - 2) Three anchors per jamb from 60 to 90 inches high.
      - 3) Four anchors per jamb from 90 to 120 inches high.
      - 4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
    - b. Stud Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
      - 1) Three anchors per jamb up to 60 inches high.
      - 2) Four anchors per jamb from 60 to 90 inches high.
      - 3) Five anchors per jamb from 90 to 96 inches high.
      - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
      - 5) Two anchors per head for frames above 42 inches wide and mounted in metal stud partitions.
  10. Door Silencers: Except on weatherstripped or gasketed doors, drill stops to receive door silencers. Silencers to be supplied by frame manufacturer regardless if specified in Division 08 Section "Door Hardware".
- E. Hardware Preparation: Factory prepare hollow metal work to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping 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 non-template, 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 Sections.

## 2.9 STEEL FINISHES

- A. Prime Finishes: Doors and frames to be cleaned, and chemically treated to insure maximum finish paint adhesion. Surfaces of the door and frame exposed to view to receive a factory applied coat of rust inhibiting shop primer.
1. Shop Primer: Manufacturer's standard, fast-curing, lead and chromate free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; and compatible with substrate and field-applied coatings.

## 2.10 LOUVERS

- A. Provide louvers for interior doors, where indicated, which comply with SDI 111.
1. Sightproof Louver: Stationary louvers constructed with inverted-V or inverted-Y blades.
    - a. Provide AFDL louver as made by Anemostat Door Products, or approved equivalent.
    - b. Custom baked enamel finish to match Architect's sample.
    - c. 22 ga. cold-rolled steel blades set into 18 ga. cold-rolled steel frame.
    - d. Tight mitered corners, no visible welds, countersunk mounting holes and corridor side of frame free of fasteners.
    - e. 50% free area.
  2. Fire-Rated Automatic Louvers: Louvers constructed with 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 by same qualified testing and inspecting agency that established fire-resistance rating of door assembly.



- a. Provide FLDL louver as made by Anemostat Door Products, or approved equivalent.
  - b. Custom baked enamel finish to match Architect's sample.
  - c. 18 ga. cold-rolled steel blades set into 18 ga. cold-rolled steel frame; 16 ga. inner support members.
  - d. Tight mitered corners, no visible welds, countersunk mounting holes and corridor side of frame free of fasteners.
  - e. 40% free area.
- B. Form corners of moldings with hairline joints. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. General Contractor to verify the accuracy of dimensions given to the steel door and frame manufacturer for existing openings or existing frames (strike height, hinge spacing, hinge back set, etc.).
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Remove welded in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded hollow metal frames for square, level, twist, and plumb condition.
- C. Tolerances shall comply with SDI-117 "Manufacturing Tolerances Standard Steel Doors and Frames."
- D. Drill and tap doors and frames to receive non-template, mortised, and surface-mounted door hardware.

### **3.3 INSTALLATION**

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11 and NFPA 80 at fire rated openings.
  - 1. Set frames accurately in position, plumbed, leveled, aligned, and braced securely until permanent anchors are set. After wall construction is complete and frames properly set and secured, remove temporary braces, leaving surfaces smooth and undamaged. Shim as necessary to comply with installation tolerances.
  - 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with post-installed expansion anchors.
  - 3. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with mortar.
  - 4. Grout Requirements: Do not grout head of frames unless reinforcing has been installed in head of frame. Do not grout vertical or horizontal closed mullion members.

- C. 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 plus or minus 1/16 inch.
    - b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
    - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
    - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
  - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
- D. Field Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with hollow metal manufacturer's written instructions.

### **3.4 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. Remove grout and other bonding material from hollow metal work immediately after installation.
- C. Prime-Coat and Painted Finish Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat, or painted finishes, and apply touchup of compatible air drying, rust-inhibitive primer, zinc rich primer (exterior and galvanized openings) or finish paint.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.

**END OF SECTION 08 11 13**

## **08 11 19 – FOOD SERVICE DOORS & FRAMES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  1. Stainless steel-clad doors.
  2. Hollow metal frames.
  3. Hardware and accessories.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, core descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.
- B. Shop Drawings: Show fabrication and installation details; include door elevations, head, jamb, and meeting stile details including full or partial gaskets.

#### **1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Store products in manufacturer's unopened packaging until ready for installation.

#### **1.5 PROJECT CONDITIONS**

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

#### **1.6 WARRANTY**

- A. Manufacturer's standard two-year warranty that products are free of defects in material and workmanship, guaranteeing to replace (exclusive of freight and labor) parts proven defective within two years after date of shipment to purchaser.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide Food Service Doors and hollow metal frames from Eliason Corporation, or approved equivalent:

#### **2.2 FOOD SERVICE DOORS**

- A. Medium to Heavy Traffic Doors: 3/4 inch (19 mm) exterior grade solid wood core; 1 inch total thickness; light to medium duty.
  1. Facing: Reinforcing metal plates. (Model SCP-3)
    - a. Full Length Panels: 18 gauge (1.27 mm) stainless steel both sides; stainless steel top hinge covers.
  2. Window Molding: Black rubber molding.
  3. Glazing: Clear acrylic.

## **2.3 HARDWARE**

- A. Hinges: Double Action Easy Swing(r) hinges by Eliason, or approved equivalent.
  - 1. Finish: Zinc coated.

## **2.4 FRAMES**

- A. Flush Hollow Metal Door Frame by Eliason, or approved equivalent.
  - 1. Pre-drilled for compression anchors.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Do not begin installation until substrates have been properly prepared.
- B. Verify jambs plumb and square; notify Architect of unsatisfactory preparation before proceeding.

### **3.2 PREPARATION**

- A. Clean surfaces thoroughly prior to installation.
- 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 accordance with manufacturer's instructions.
- B. Reinforce hollow metal jambs at hardware locations.

### **3.4 PROTECTION**

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Plastic Materials
  - 2. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.

**END OF SECTION 08 11 13**

## **08 12 16 – INTERIOR ALUMINUM FRAMES & DOORS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Pre-finished aluminum door frames for interior use.
    - a. Rated and unrated.
  - 2. Pre-finished aluminum framing systems for interior use.
  - 3. Pre-finished aluminum doors for interior use.
- B. Related Sections:
  - 1. See Division 07 Section "Joint Sealants" for pre-compressed, self-expanding foam joint sealant used in this section.
  - 2. Division 08 Section "Glazing" for glass view panels in interior aluminum doors.
  - 3. Division 08 Sections "Flush Wood Doors" for wood doors used in interior aluminum frames.
  - 4. Division 08 Sections "Door Hardware" and "Door Hardware Sets" for door hardware used on interior aluminum doors and frames.
  - 5. Division 28 Section "Access Control" for access control devices installed at interior aluminum frame openings and provided as part of a security access system.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, hardware reinforcements, profiles, anchors, fire-resistance rating, and finishes.
  - 1. Product data for 90 minute fire rated door frames.
- B. Templates: Door hardware supplier is to furnish templates, template reference number and/or physical hardware to the interior aluminum door and frame supplier in order to prepare the doors and frames to receive the finish hardware items.
- C. Shop Drawings: Include the following:
  - 1. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
  - 2. Locations of reinforcement and preparations for hardware.
  - 3. Details of each different wall opening condition. Include requirements for steel framing at partitions for fit and securing of frames, partition widths and tolerances, direction of framing members, clips and attachments.
  - 4. Details of anchorages, joints, field splices, and connections.
  - 5. Details of accessories.
  - 6. Details of moldings, removable stops, and glazing.
  - 7. Elevations of each door design.
  - 8. Details of doors, including vertical and horizontal edge details and metal thicknesses.
  - 9. Details of preparations for power, signal, and control systems.
- D. Samples for Verification: Provide at the request of architect, prepared Samples as indicated below:
  - 1. Framing Member: 12 inches long.
  - 2. Corner Fabrication: 12-by-12-inch-long, full-size window corner, including full-size sections of extrusions with factory-applied color finish.

3. Aluminum chips in full range manufacturer's standard finishes for architect's color selection.
- E. Mockup: Provide in place mockup of one interior aluminum frame, door and glass sidelight for approval, before proceeding with remainder of job.
- F. Interior Aluminum Door and Frame Schedule: Use same designations indicated on Drawings. Coordinate with Door Hardware schedule and glazing.

#### **1.4 QUALITY ASSURANCE**

- A. Source Limitations: Obtain interior aluminum frames and doors through one source from a single qualified manufacturer.
- B. Manufacturer Qualifications: A firm experienced in the manufacturing of interior aluminum framing systems and doors with a minimum ten (10) years successful in-service performance providing product similar to those indicated for this project, including pre-engineering and pre-fabricating all components of aluminum framing systems and doors.
- C. Installer Qualifications: An experienced installer with a minimum five years (5) experience who has completed aluminum framing systems and door installations similar in material, design, and extent to those indicated for this project and whose work has resulted in construction with a record of successful in-service performance.
- D. Aesthetic Effects: Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- E. 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 (neutral pressure at 40" above sill) or UL 10C.
- F. Provide labels permanently fastened on each frame or door within size limits established by NFPA and the testing authority.
- G. Pre-Installation Conference: Conduct conference with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for installing interior aluminum frames and doors and to verify installation of electrical knockout boxes and conduit at frames with electrified or access control hardware.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver interior aluminum frames and doors individually protective wrapped within cartons and marked for the corresponding scheduled opening. Do not bulk pack frames.
- B. Inspect frames upon delivery for damage.
  1. Repair minor damage to pre-finished products as recommended by manufacturer.
  2. Replace frames that cannot be satisfactorily repaired.
- C. Store interior aluminum frames and doors at Project site under cover and as near as possible to final installation location. Do not use covering material that will cause discoloration of aluminum finish.

#### **1.6 PROJECT CONDITIONS**

- A. Field Measurements: Verify actual dimensions of interior aluminum frame openings by field measurements before fabrication and indicate measurements on Shop Drawings submittals.

- B. Do not install aluminum frames and doors until area of work has been completely enclosed and interior is protected from the elements.
- C. Maintain temperature and humidity in areas of installation within reasonable limits, as close as possible to final occupancy standards. If necessary, provide artificial heating, cooling and ventilation to maintain required environmental conditions.

## **1.7 WARRANTY**

- A. Provide manufacturer's written two year warranty against defects in materials and workmanship upon final completion and acceptance of Work in this section.
  - 1. Warrant framing and door finishes against defects and excessive fading and non-uniformity in color for a period of 5 years.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Basis of Design: Provide product listed below, or approved equivalent:
  - 1. Wilson Partitions, Stamford, CT

### **2.2 MATERIALS**

- A. Extruded Aluminum: ASTM B 221 alloy 6063-T5 or alloy and temper required to assure compliance with tight dimensional tolerances and maintain color uniformity.
- B. Extruded Aluminum Frames:
  - 1. Snap-On Trim Profile: Provide frames with the following characteristics:
    - a. Rectilinear design.
    - b. Trim and throat size as shown on Drawings.
    - c. Glass types and thickness as shown on Drawings and in Division 08 Section "Glazing."
    - d. Provide 90 minute fire rated frames where indicated on the Door Schedule.
- C. Interior Aluminum Doors
  - 1. General: Provide 1-3/4 inch doors of type and design indicated, not less than 0.062 inch thick material. Use Wilson Partitions, MS362 Medium Stile Door or an approved equivalent.
  - 2. Aluminum Stile & Rail Type Swinging Doors: Door stiles and rails to have tubular design with the following characteristics:
    - a. Stile Width: 3-1/2".
    - b. Rail Width: 3-5/8", with 10" bottom rail to meet ADA requirements.
  - 3. Snap-in stops with factory applied glazing gaskets.

### **2.3 ACCESSORIES**

- A. Fasteners: Aluminum, nonmagnetic, stainless-steel or other noncorrosive metal fasteners compatible with frames, stops, panels, reinforcement plates, hardware, anchors, and other items being fastened.
- B. Door Silencers: Manufacturer's standard continuous mohair, wool pile, or vinyl seals.
- C. Glazing Gaskets: Manufacturer's standard extruded or molded plastic, to accommodate glazing thickness indicated.
- D. Polyethylene foam tape for acoustical seal.
- E. Glazing: Comply with requirements in Division 08 Section, "Glazing."

- F. Hardware: As specified in Division 08 Sections "Door Hardware" and "Door Hardware Sets."

## 2.4 FABRICATION

### A. Frame Construction

1. Factory pre-engineer and pre-cut interior aluminum frame components to the greatest extent practical. Linear glazing components fabricated in the field are not allowed. Allow for 2 inches excess vertical length for scribing to suit floor conditions. Machine jambs and prepare for hardware, with concealed plates, drilled and tapped as required, fastened in frame with concealed screws.
2. Provide concealed corner reinforcements and alignment clips for precise joints at butt or mitered connections.
3. Hardware Preparation: Factory interior aluminum frames to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates as specified in Division 08 Section, "Door Hardware."
  - a. Reinforce frames to receive surface mounted door hardware. Machine jambs and prepare for hardware, with concealed reinforcement plates, drilled and tapped as required and fastened within frame with concealed screws.
  - b. Locate hardware as indicated.
  - c. Coordinate locations of conduit, wiring boxes, and power transfers for electrical connections with Division 26 Sections.
4. Fabricate frames for glazing with removable stops to allow glazing replacement without dismantling frame.
5. Fabricate all components to allow secure installation without exposed fasteners.

### B. Door Construction

1. Factory pre-engineer aluminum doors and components to the greatest extent practical.
2. Hardware Preparation: Factory interior aluminum doors to receive template mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates as specified in Division 08 Section, "Door Hardware."
  - a. Reinforce doors to receive surface mounted door hardware. Machine and prepare for hardware, with concealed reinforcement plates, drilled and tapped as required and fastened within door with concealed screws.
  - b. Locate hardware as indicated.
  - c. Coordinate locations of conduit and power transfers for electrical connections with Division 26 Sections.
3. Clearances for Non-Fire-Rated Door Frames: Not more than 1/8 inch at jambs and heads, not more than 1/4 inch between pairs of doors. Not more than 3/4 inch at bottom.
4. Fabricate kits for glazing with removable stops to allow glazing replacement without dismantling.

## 2.5 ALUMINUM FINISHES

### A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for apply and designated finishes. Exposed surfaces to be free of scratches and other serious blemishes.

1. Factory finish extruded frame components so that any part exposed to view upon completion of installation will be uniform in finish and color.
2. Flurocyl Coating: Comply with AAMA (2603) 603.8 and AA-DAF-45.
  - a. Factory applied painted finish.
  - b. Color coat: Dry film thickness 0.8 +/- 0.05 mil.
  - c. Color: As selected by Architect.
    - 1) Custom color to match Architect's sample.
    - 2) Two colors will be used.



## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify wall thickness does not exceed standard tolerances allowed by specified frame throat sizes.
- C. General Contractor to verify the accuracy of dimensions given to frame and door manufacturer for pre-cut openings.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. General: Install and set interior aluminum frames plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
  - 1. At fire-protection-rated openings, install frames according to NFPA 80 and NFPA 105.
  - 2. Comply with frame manufacturer's printed installation instructions and approved shop drawings. Strictly adhere to maintaining specified wall thickness to insure dimension does not exceed frame throat size specified. Installation not to be attempted in areas where the wall thickness exceeds the tolerance of the specified throat size.
  - 3. Install frames plumb and square, securely anchored to substrates with fasteners recommended by frame manufacturer.
    - a. Use concealed installation clips to assure that splices and connections are tightly butted and properly aligned.
    - b. Secure clips to main structural extrusion components and not to snap-in or trim members.
    - c. Do not use screws or other fasteners that will be exposed to view when installation is complete.
- B. Install polyethylene foam tape at all perimeter jamb, head and sill conditions where storefront system meets adjacent materials.
- C. Install pre-compressed self-expanding foam joint sealant between jambs and recessed aluminum wall base.
  - 1. Recess foam seal from face of jamb on both sides of glass wall system. See Drawings.

### **3.3 ADJUSTING AND CLEANING**

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition.
- B. Clean exposed frame surfaces promptly after installation, using cleaning methods recommended by frame manufacturer and according to AMMA 609 & 610.
- C. Touch up marred areas so that touch up is not visible from a distance of 48 inches. Remove and replace frames that cannot be satisfactorily repaired.

### **3.4 PROTECTION**

- A. Provide protection as required to assure that frames will be without damage or deterioration upon substantial completion of the project.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.

**END OF SECTION 08 12 16**

## **08 14 16 – FLUSH WOOD DOORS**

### **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. Section Includes:
  - 1. Solid core doors with wood veneer faces.
  - 2. Factory finishing (primed) wood doors.
  - 3. Factory fitting wood doors to frames and factory machining for hardware.
  - 4. Light frames and glazing installed in wood doors.
- B. Related Sections:
  - 1. Division 08 Section "Door Hardware Sets".
  - 2. Division 08 Section "Hollow Metal Doors and Frames".
  - 3. Division 08 Section "Interior Aluminum Doors and Frames".
  - 4. Division 08 Section "Glazing".
  - 5. Division 08 Section "Door Hardware".
  - 6. Division 28 Section "Access Control".
- C. Standards and References: Comply with the version year adopted by the Authority Having Jurisdiction.
  - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
  - 2. ANSI A208.1 – Wood Particleboard.
  - 3. Intertek Testing Service (ITS Warnock Hersey) - Certification Listings for Fire Doors.
  - 4. NFPA 80 - Standard for Fire Doors and Fire Windows; National Fire Protection Association.
  - 5. UL 10C - Positive Pressure Fire Tests of Door Assemblies; UL 1784 - Standard for Air Leakage Tests of Door Assemblies.
  - 6. Window and Door Manufacturers Association - WDMA I.S.1-A Architectural Wood Flush Doors.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type of door indicated. Include details of core and edge construction, louvers, trim for openings, and WDMA I.S.1-A classifications. Include factory finishing specifications.
- B. Shop Drawings shall include:
  - 1. Indicate location, size, and hand of each door.
  - 2. Indicate dimensions and locations of mortises and holes for hardware.
  - 3. Indicate dimensions and locations of cutouts.
  - 4. Indicate requirements for veneer matching.
  - 5. Indicate location and extent of hardware blocking.
  - 6. Indicate construction details not covered in Product Data.
  - 7. Indicate doors to be factory finished and finish requirements.
  - 8. Indicate fire protection ratings for fire rated doors.
- C. Samples for Initial Selection: For factory finished doors.
  - 1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of

three samples showing typical range of color and grain to be expected in the finished work.

2. Frames for light openings, 6 inches long, for each material, type, and finish required.

D. Warranty: Provide sample of manufacturer's warranty.

#### **1.4 QUALITY ASSURANCE**

A. Source Limitations: Obtain flush wood doors through one source from a single manufacturer wherever possible.

B. Quality Standard: In addition to requirements specified, comply with WDMA I.S.1-A, latest edition, "Industry Standard for Architectural Wood Flush Doors'.

C. Fire Rated Wood Doors: Doors 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 at positive pressure according to NFPA 252 (neutral pressure at 40" above sill) or UL10C.

1. Oversize Fire Rated Door Assemblies: For units exceeding sizes of tested assemblies provide manufacturer's construction label, indicating compliance to independent 3<sup>rd</sup> party certification agency's procedure, except for size.
2. Temperature Rise Limit: Where required and at vertical exit enclosures (stairwell openings) and exit passageways, provide doors that have a maximum transmitted temperature end point of not more than 450 deg F (250 deg C) above ambient after 30 minutes of standard fire test exposure.
3. Smoke Control Door Assemblies: Comply with NFPA 105.
  - 1) Smoke "S" Label: Doors to bear "S" label, and include smoke and draft control gasketing applied to frame and on meeting stiles of pair doors.

D. Pre-Submittal Conference: Conduct conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier, Installer, and Contractor to review proper methods and procedures for receiving, handling, and installing flush wood doors.

#### **1.5 DELIVERY, STORAGE, AND HANDLING**

A. Comply with requirements of referenced standard and manufacturer's written instructions.

B. Package pre-finished doors individually in plastic bags and wrap bundles of doors in plastic sheeting.

C. Mark each door on top rail with opening number used on Shop Drawings.

#### **1.6 PROJECT CONDITIONS**

A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weather tight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

#### **1.7 WARRANTY**

A. 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 in a 42-by-84-inch section.
  - b. Telegraphing of core construction in wood face veneers exceeding 0.01 inch in a 3-inch span.

2. Warranty includes 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. WDMA I.S.1-A Performance Grade: Extra Heavy Duty; Aesthetic Grade: Premium.
- B. Fire Rated Doors: Provide construction and core as needed to provide fire ratings indicated.
  1. Category A Edge Construction: Provide fire rated door edge construction with intumescent seals concealed by outer stile (Category A) at 45, 60, and 90 minute rated doors. Comply with specified requirements for exposed edges.
  2. Pairs: Provide stiles with concealed intumescent seals. Comply with specified requirements for exposed edges.
    - a. Provide fire retardant stiles that are listed and labeled for applications indicated without formed steel edges and astragals.

### **2.2 CORE CONSTRUCTION**

- A. Particleboard Core Doors:
  1. Particleboard: Wood fiber based materials complying with ANSI A208.1 Particleboard standard. Grade LD-2.
  2. Adhesive: Fully bonded construction using Polyurethane (PUR) glue.
  3. Blocking: As indicated under article "Blocking".
- B. Fire Resistant Composite Core Doors:
  1. Core: Non-combustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire protection rating indicated.
  2. Blocking: As indicated under article "Blocking".
  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.

### **2.3 BLOCKING**

- A. Fire Rated Doors:
  1. Provide blocking as indicated below:
    - a. HB1: 5 inch in doors indicated to have closers and overhead stops.
    - b. HB2: 5 inch bottom rail blocking in doors indicated to have kick plates.
    - c. HB3: 5 inch top and bottom rail blocking in doors indicated to have closers and kick plates.
    - d. HB4: Two 5 inch x 14 inch lock blocking in doors indicated to have exit devices.
    - e. HB5: Two 5 inch x 14 inch corner blocking in doors indicated to have flush bolts.
    - f. HB6: 5 inch mid-rail blocking in doors indicated to have exit devices.
    - g. HB7: 5 inch stile blocking.
    - h. HB8: Two 5 inch x 14 inch corner blocking and two 5 inch x 14 inch lock blocking on doors to have vertical rod exit devices.

### **2.4 DOORS FOR OPAQUE FINISH**

- A. Manufacturers: Basis of Design: Provide the products listed below, or approved equivalent.
  1. ASSA ABLOY Wood Doors (GR): GCD Series.
  2. Eggers Industries (EG): Custom Series.
- B. Interior Solid Core Doors:
  1. Grade: Custom.

2. Faces: Any closed-grain hardwood of mill option.
3. Exposed Vertical and Top Edges: Any closed-grain hardwood.
4. Core: Particleboard unless otherwise noted.
5. Construction: Five plies. Stiles and rails are bonded to core, then entire unit sanded before applying face veneers.

## **2.5 LIGHT FRAMES AND GLAZING**

- A. Metal Frames for Light Openings in Fire Rated Doors over 20-minute Rating: Manufacturer's standard frame formed of 0.048-inch-thick, cold rolled steel sheet; with baked enamel or powder coated finish; and approved for use in doors of fire protection rating indicated.
  1. Manufacturers: Basis of Design: Provide the manufacturer listed below, or approved equivalent.
    - a. Pemko (PE).
- B. Glazing: Comply with installation requirements in Division 08 Section "Glazing" and with the flush wood door manufacturer's written instructions.

## **2.6 FABRICATION**

- A. Factory fit doors to suit frame opening sizes indicated.
  1. Comply with requirements in NFPA 80 for fire rated doors.
  2. Undercut: As required per manufacturer's templates and sill condition.
- B. Factory machine doors for hardware that is not surface applied. Comply with final hardware schedules, door frame Shop Drawings, DHI A115-W series standards, and hardware templates.
  1. Coordinate with hardware mortises in metal frames to verify dimensions and alignment before factory machining.
  2. Metal Astragals: Factory machine astragals and formed steel edges for hardware for pairs of fire rated doors.
- C. Openings: Cut and trim openings through doors in factory.
  1. Light Openings: Trim openings with moldings of material and profile indicated.
  2. Glazing: Comply with applicable requirements in Division 08 Section "Glazing."
  3. Louvers: Factory install louvers in prepared openings.
- D. Electrical Raceways: Provide flush wood doors receiving electrified hardware with concealed wiring harness and standardized Molex™ plug connectors on both ends to accommodate up to twelve wires. Coordinate connectors on end of the wiring harness to plug directly into the electrified hardware and the through wire transfer hardware or wiring harness specified in hardware sets in Division 08 "Door Hardware". Wire nut connections are not acceptable.

## **2.7 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. Opaque Finish: Field applied finish.
  1. Factory primed.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine doors and installed door frames before hanging doors.

1. Verify that frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
  2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Hardware: For installation, see Division 8 Sections "Door Hardware" and "Door Hardware Sets."
- B. Installation Instructions: Install doors and frames to comply with manufacturer's written instructions and the referenced quality standard, and as indicated.
- C. Install fire rated doors in corresponding fire rated frames according to NFPA 80.
- D. Factory Fitted Doors: Align in frames for uniform clearance at each edge.
- E. Factory Finished Doors: Restore finish before installation if fitting or machining is required at Project site.
- F. Field modifications to doors shall not be permitted, except those specifically allowed by manufacturer or fire rating requirements.

### **3.3 ADJUSTING**

- A. Operation: Re-hang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that do not comply with requirements. Doors may be repaired or refinished if work complies with requirements and shows no evidence of repair or refinishing.

### **3.4 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
1. Aluminum.
  2. Plastic Materials
  3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
1. Treated, stained, painted or contaminated wood.

**END OF SECTION 08 14 16**

## **SECTION 08 14 33 – STILE & RAIL WOOD DOORS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Interior stile and rail wood doors.
  - 2. Fitting stile and rail wood doors to frames and machining for hardware.
  - 3. Factory finishing of stile and rail wood doors.
- B. Related Requirements:
  - 1. Division 06 Section "Interior Architectural Woodwork" for requirements for veneers from the same flitches for both architectural woodwork and stile and rail wood doors.
  - 2. Division 08 Section "Glazing" for glass vision panels in stile and rail doors.
  - 3. Division 08 Sections "Door Hardware" and "Door Hardware Sets."

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product, including the following:
  - 1. Details of construction and glazing.
  - 2. Factory-priming specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data, including those for stiles, rails, panels, and moldings (sticking); and other pertinent data, including the following:
  - 1. Door schedule indicating door location, type, size and swing.
  - 2. Door elevations, dimensions and location of hardware, lite locations, and glazing thickness.
  - 3. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
  - 4. Dimensions and locations of mortises and holes for hardware.
  - 5. Clearances and undercuts.
  - 6. Doors to be factory finished, and finish requirements.
- C. Samples for Initial Selection: For factory-finished doors.
- D. Samples for Verification:
  - 1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish.
  - 2. Corner sections of doors, approximately 8 by 10 inches, with door faces and edges representing actual materials to be used.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Sample Warranty: For special warranty.
- B. Product Certificates: For each type of door, from manufacturer.



## **1.6 CLOSEOUT SUBMITTALS.**

- A. Special warranties.
- B. Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

## **1.7 QUALITY ASSURANCE**

- A. Manufacturer's Certification: Licensed participant in AWI's Quality Certification Program.

## **1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Package doors individually in opaque plastic bags or cardboard cartons.
- C. Mark each door on bottom rail with opening number used on Shop Drawings.

## **1.9 FIELD CONDITIONS**

- A. Environmental Limitations: Do not deliver or install doors until building is enclosed and weathertight, wet work is complete and dry, and HVAC system is operating and maintaining temperature between 60 and 90 deg F and relative humidity between 17 and 50 percent during remainder of construction period.

## **1.10 WARRANTY**

- A. Special Warranty: 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. Delamination of veneer.
    - b. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
    - c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
  - 2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
  - 3. Warranty shall be in effect during specified period of time from date of Substantial Completion.
  - 4. Warranty Period for Interior Doors: Life of installation.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Source Limitations: Obtain stile and rail wood doors from single manufacturer.

### **2.2 MATERIALS**

- A. Use only materials that comply with referenced standards and other requirements specified.
  - 1. Assemble interior doors, including components, with either dry-use or wet-use adhesives complying with ASTM D5572 for finger joints and with ASTM D5751 for joints other than finger joints.
- B. Panel Products: Any of the following unless otherwise indicated:
  - 1. Particleboard: ANSI A208.1, Grade M-2.
  - 2. Medium-density fiberboard (MDF,) complying with ANSI A208.2, Grade 130.
  - 3. Hardboard complying with ANSI A135.4.
  - 4. Veneer-core plywood.

- C. Safety Glass: Provide products complying with testing requirements in 16 CFR 1201, for Category II materials, unless those of Category I are expressly indicated and permitted.

### **2.3 INTERIOR STILE AND RAIL WOOD DOORS**

- A. Interior Stile and Rail Wood Doors: Custom interior doors complying with AWI's "Architectural Woodwork Quality Standards," and with other requirements specified.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Algoma Hardwoods, Inc.
    - b. Eggers Industries.
    - c. Enjo Architectural Millwork.
    - d. Maiman Company (The).
    - e. Pinecrest, Inc.
    - f. Select Interior Door, Ltd.
    - g. TruStile Doors LLC.
    - h. Woodtech Trading Company.
    - i. Or approved equivalent.
  - 2. Panel Designs: Indicated by Drawings. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
  - 3. Grade: Premium.
  - 4. Finish: Transparent.
  - 5. Wood Species and Cut for Transparent Finish: Select clear maple, plain sliced or sawn.
    - a. Wood species, cut and finish to match adjacent millwork in Special Collections Reading Room.
  - 6. Door Construction for Transparent Finish:
    - a. Stile and Rail Construction: Clear lumber; may be edge glued for width. Select lumber for similarity of grain and color and arrange for optimum match between adjacent pieces.
    - b. Thickness: As scheduled.
  - 7. Stile and Rail Widths: As indicated.
  - 8. Molding Profile (Sticking): Flat bead stop.
  - 9. Glass: As indicated in door schedule, complying with Division 08 Section "Glazing."
  - 10. Provide AWI Quality Certification Labels or an AWI letter of licensing for Project indicating that doors comply with requirements of grades specified.
  - 11. Finishing: Factory finish this door type according to finishing requirements in this Section.

### **2.4 STILE AND RAIL WOOD DOOR FABRICATION**

- A. Factory fit doors to suit frame-opening sizes indicated, with the following uniform clearances and bevels unless otherwise indicated:
  - 1. Clearances:
    - a. Provide 1/8 inch at heads, jambs, and between pairs of doors.
    - b. Provide 1/2 inch from bottom of door to top of decorative floor finish or covering.
    - c. Where threshold is shown on Drawings or scheduled, provide not more than 3/8 inch from bottom of door to top of threshold.
  - 2. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
- B. Fabricate stile and rail wood doors in sizes indicated for field fitting.
- C. Factory machine doors for hardware that is not surface applied.
  - 1. Locate hardware to comply with DHI-WDHS-3.
  - 2. Comply with final hardware schedules, door frame Shop Drawings, BHMA-156.115-W, and hardware templates.
  - 3. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.

4. Coordinate measurements of hardware mortises in metal frames to verify dimensions and alignment before factory machining.
- D. Glazed Openings: Factory install glazing in doors, complying with Division 08 Section "Glazing." Install glass using manufacturer's standard elastomeric glazing sealant complying with ASTM C920. Secure glass in place with removable wood moldings. Miter wood moldings at corner joints.

## **2.5 FINISHING**

- A. Finish wood doors at factory.
- B. For doors indicated to be factory finished, comply with AWI's "Architectural Woodwork Quality Standards," WDMA I.S.6A, "Industry Standard for Architectural Stile and Rail Doors," and with other requirements specified.
1. Finish faces and all four edges of doors, including mortises and cutouts. Stains and fillers may be omitted on top and bottom edges, edges of cutouts, and mortises.
- C. Transparent Finish:
1. Grade: Premium.
  2. Finish: AWI catalyzed polyurethane system.
  3. Staining: Match Architect's sample.
  4. Effect: Filled finish.
  5. Sheen: Satin.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine doors and installed door frames, with Installer present, before hanging doors.
1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
  2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Hardware: For installation, see Division 08 Sections 'Door Hardware' and 'Door Hardware Sets.'
- B. Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
- C. Job-Fitted Doors:
1. Align and fit doors in frames with uniform clearances and bevels as indicated below.
    - a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.
  2. Machine doors for hardware.
  3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
  4. Clearances:
    - a. Provide 1/8 inch at heads, jambs, and between pairs of doors.
    - b. Provide 1/2 inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
    - c. Where threshold is shown on Drawings or scheduled, provide 3/8 inch from bottom of door to top of threshold unless otherwise indicated.
  5. Bevel non-fire-rated doors 1/8 inch in 2 inches at lock and hinge edges.
- D. Factory-Fitted Doors: Align in frames for uniform clearance at each edge.

- E. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

### **3.3 ADJUSTING**

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

### **3.4 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
  - 1. Separate tempered glass waste for use as aggregate of nonstructural fill.
- C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 08 14 33**

## **SECTION 08 31 13 - ACCESS DOORS AND FRAMES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes access doors and frames for walls and ceilings.
- B. Related Requirements:
  - 1. Division 08 Section "Door Hardware" for mortise or rim cylinder locks and master keying.
  - 2. Division 09 Section "Painting" for requirements for shop priming.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, fire ratings, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Samples: For each type of access door and frame and for each finish specified, complete assembly minimum 6 by 6 inches in size.
- C. Product Schedule: For access doors and frames.
  - 1. All locations must be submitted to the Architect for approval prior to installation.
- D. Shop Drawings:
  - 1. Include plans, elevations, sections, details, and attachments to other work.
  - 2. Detail fabrication and installation of access doors and frames for each type of substrate.

### **PART 2 - PRODUCTS**

#### **2.1 PERFORMANCE REQUIREMENTS**

- A. Fire-Rated Access Doors and Frames: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency, for fire-protection and temperature-rise limit ratings indicated, according to NFPA 252 or UL 10B.

#### **2.2 ACCESS DOORS AND FRAMES**

- A. Flush Access Doors with Concealed Flanges:
  - 1. Description: Face of door flush with frame; with concealed flange for gypsum board installation and concealed hinge.
  - 2. Locations: Wall and ceiling.
  - 3. Uncoated Steel Sheet for Door: Nominal 0.060 inch, 16 gage, factory primed.
  - 4. Stainless-Steel Sheet for Door: Nominal 0.062 inch, 16 gage, No. 4 finish. Use at wet locations in non-rated construction.
  - 5. Frame Material: Same material and thickness as door.
  - 6. Latch and Lock: Cam latch, screwdriver operated with interior release.

#### **2.3 FIRE-RATED ACCESS DOORS AND FRAMES**

- A. Fire-Rated, Flush Access Doors with Concealed Flanges:

1. Description: Door face flush with frame, with a core of mineral-fiber insulation enclosed in sheet metal; with concealed flange for gypsum board installation, self-closing door, and concealed hinge.
2. Locations: Wall and ceiling.
3. Fire-Resistance Rating: Not less than that indicated.
4. Temperature-Rise Rating: 250 deg F at the end of 30 minutes.
5. Uncoated Steel Sheet for Door: Nominal 0.036 inch, 20 gage, factory primed.
6. Stainless-Steel Sheet for Door: Nominal 0.038 inch, 20 gage, No. 4 finish, for wet locations in fire-rated construction.
7. Frame Material: Same material, thickness, and finish as door.
8. Latch and Lock: Self-closing, self-latching door hardware, with cylinder lock.
  - a. Lock Preparation: Prepare door panel to accept cylinder specified in Division 08 Section "Door Hardware."

## **2.4 MATERIALS**

- A. Steel Plates, Shapes, and Bars: ASTM A36/A36M.
- B. Steel Sheet: Uncoated or electrolytic zinc coated, ASTM A879/A879M, with cold-rolled steel sheet substrate complying with ASTM A1008/A1008M, Commercial Steel (CS), exposed.
- C. Stainless Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666, Type 304. Remove tool and die marks and stretch lines, or blend into finish.
- D. Frame Anchors: Same material as door face.
- E. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.
- F. Drywall Beads: Edge trim formed from 0.0299-inch zinc-coated steel sheet formed to receive joint compound and in size to suit thickness of gypsum board.

## **2.5 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 in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
  1. For concealed flanges with drywall bead, provide edge trim for gypsum panels securely attached to perimeter of frames.
  2. For concealed flanges with plaster bead for full-bed plaster applications, provide zinc-coated expanded-metal lath and exposed casing bead welded to perimeter of frames.
- D. Latch and Lock Hardware:
  1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
  2. Keys: Furnish two keys per lock and key all locks alike.

## **2.6 FINISHES**

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Painted Finishes: Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
  - 1. Factory Primed: Apply manufacturer's standard, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.
  - 2. Factory Finished: Apply manufacturer's standard powder-coat finish immediately after cleaning and pretreating, with minimum dry-film thickness of 1 mil for topcoat.
    - a. Color: Match Architect's sample; access doors to match paint color selected for adjacent ceiling.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. Comply with manufacturer's written instructions for installing access doors and frames.

#### **3.3 ADJUSTING**

- A. Adjust doors and hardware, after installation, for proper operation.

#### **3.4 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

### **END OF SECTION 08 31 13**

## **08 32 13 – ALUMINUM SLIDING WINDOWS & DOORS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Thermally broken aluminum-framed lift & slide glass door.
  - 2. Sliding glass access window, interior.
- B. Related Sections:
  - 1. Division 08 Section "Glazing".

#### **1.3 SUBMITTALS**

- A. Product Data:
  - 1. Construction details and fabrication methods
  - 2. Profiles and dimensions of individual components
  - 3. Recommendations for maintaining and cleaning exposed surfaces.
- B. Shop Drawings: For each type of aluminum-framed product indicated. Include information not fully detailed in manufacturer's standard Product Data and the following:
  - 1. Fabrication, layout, and installation details, including anchors .Show adjacent construction and methods of attachment and flashing.
  - 2. Typical door and window elevations.
  - 3. Hardware.
  - 4. Glazing details
  - 5. Accessories.
- C. Samples:
  - 1. One (1) 12 inch long section of each profile.
  - 2. Color samples of custom finish to match aluminum curtain wall framing.
- D. Calculations:
  - 1. Structural test pressures and design pressures from basic wind speeds indicated.
  - 2. Deflection limitations of glass framing systems.

#### **1.4 QUALITY ASSURANCE**

- A. Installer Qualifications: An experienced installer who has completed sliding aluminum-framed glass door installations similar in material, design, and extent to those indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- B. Engineer Qualifications: Structural engineer who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for determining wind load capacities for aluminum-framed glass door installations that are similar to those indicated for this Project in material, design, and extent.
- C. Product Options: Drawings indicate size, profiles, dimensional requirements, and aesthetic effects of thermally broken windows and doors and are based on the specific product indicated.



- D. Aluminum-Framed Product Standard: Comply with provisions of AAMA/WDMA/CSA 101/I.S.2/A440 for standards of performance, materials, components, and fabrication.

## **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver Aluminum units and materials to the project site clearly marked for proper identification.
- B. Store units in accordance with manufacturer's instructions, above ground, in dunnage and protected from weather, construction activities and other cause of damage or loss.
- C. Handle units at the job site in such a manner as to prevent damage. Removed from the job site, damaged or otherwise unsuitable units when so ascertained.

## **1.6 PROJECT CONDITIONS**

- A. Field Measurements: Verify actual dimensions of interior aluminum frame openings by field measurements before fabrication and indicate measurements on Shop Drawings submittals.
- B. Do not install aluminum frames and doors until area of work has been completely enclosed and interior is protected from the elements.
- C. Maintain temperature and humidity in areas of installation within reasonable limits, as close as possible to final occupancy standards. If necessary, provide artificial heating, cooling and ventilation to maintain required environmental conditions.

## **1.7 WARRANTY**

- A. Provide manufacture's written warranty, stating that the product will be without failure in materials or workmanship in accordance with the General Conditions, except the warranty period is to be for three (3) years.
- B. The warranty is to cover materials to repair failures which include, but are not limited to, the following
  - 1. Structural failures, including excessive deflection, water leakage, air infiltration, or condensation.
  - 2. Faulty operation of movable panels and hardware, but not including adjustments for maintenance.
  - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
- C. Hardware:
  - 1. Provide manufacturer's written limited warranty stating that hardware and accessories to be free of any defects, in both material and craftsmanship, properties, functionality, and design in accordance with the General Conditions except the warranty period is to be for:
    - a. Five (5) years for manufacturing defects.
- D. The above warranties are in addition to, and not a limitation of, other rights the Owner may under the Contract Documents.

## **PART 2 - PRODUCTS**

### **2.1 LIFT AND SLIDE DOOR**

- A. Manufacturer: Basis of Design: Provide product listed below, or approved equivalent.
  - 1. Reynaers Aluminum via Dynamic Windows and Doors Inc.
  - 2. Model CP 155 Lift & Slide; thermally broken construction.
- B. Aluminum Extrusions: Provide alloy and temper recommended by aluminum-framed glass door manufacturer for strength, corrosion resistance, and application of required finish, but not less

than 22,000 psi ultimate tensile strength and not less than 0.062 inch thickness at any location for the main frame and panel members.

- C. Threshold: Low profile threshold for ADA compliance.
- D. Fasteners: Provide aluminum, nonmagnetic stainless steel, epoxy adhesive, or other materials warranted by manufacturer to be noncorrosive and compatible with aluminum-framed members, trim, hardware, anchors, and other components.
  - 1. Reinforcement: Where fasteners screw-anchor into aluminum less than 0.125 inch thick, reinforce interior with aluminum or nonmagnetic stainless steel to receive screw threads, or provide standard, noncorrosive, pressed-in, splined grommet nuts.
  - 2. Exposed to View Fasteners: Unless unavoidable for applying hardware, do not use exposed fasteners. For application of hardware, use fasteners that match finish of member or hardware being fastened, as appropriate. Exposed fasteners when used are subject to review by the Architect.
- E. Anchors, Clips, Fixing Lugs, Fastening Straps, and Accessories: Provide anchors, clips, and accessories of aluminum, nonmagnetic stainless steel, galvanized steel, or zinc-coated steel or iron complying with ASTM B 633 for SC 3 (severe) service conditions; provide sufficient strength to withstand design pressure indicated.
  - 1. Weather-Stripping Material: Manufacturer's standard system and materials complying with AAMA/WDMA/CSA 101/I.S.2/A440.
- F. Glass: Provide insulating-glass units that comply with safety glazing requirements and with Division 08 Section "Glazing."
- G. Glazing System: Provide manufacturer's standard glazing system that produces weather-tight seal.
- H. Insulation: Provide insulation complying with the requirements of Division 07 Section "Thermal Insulation."
- I. Sealant: Provide sealant. Comply with the requirements of Division 07 Section "Joint Sealants."

## **2.2 HARDWARE**

- A. General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, or other corrosion-resistant material compatible with aluminum; designed to smoothly operate, tightly close, and securely lock. Do not use aluminum in frictional contact with other metals. Where exposed, provide solid bronze; extruded, cast, or wrought aluminum; solid white metal with special coating finish; or nonmagnetic stainless steel.
  - 1. Threshold and Sill Cap/Track: Provide extruded-aluminum threshold of thickness, dimensions, and profile indicated in shop fabrication drawings; designed to comply with performance requirements indicated and to drain to the exterior; with manufacturer's standard finish.
  - 2. Door Handles: Selected from full range of manufacturer's options.
    - a. Finish: Stainless steel or brushed chrome over solid brass.
  - 3. Locks: Multi-point locking system, keyed to Owner's master cylinder system.

## **2.3 SLIDING INTERIOR PASS-THROUGH WINDOW**

- A. Basis of Design: C.R. Laurence Co., or approved equivalent.
  - 1. SW Series sliding service window.
- B. Medium-duty commercial sliding service window, constructed of 6063-T5 extruded aluminum.
  - 1. Window glides on top-hung nylon slides.
  - 2. Poly-pile weather stripping and side locks.

3. Finish: Powder coat finish to match Architect's sample.
  4. Glazing: 1/4" clear tempered glass.
  5. Provide laminated shelf.
    - a. Laminate color to be selected from manufacturer's full range of colors.
- C. Location: Office 307A.
1. See Drawings for dimensions and details.

## 2.4 FABRICATION

- A. General: Fabricate aluminum-framed product in sizes indicated that comply with requirements and that meet or exceed AAMA/WDMA/CSA 101/I.S.2/A440 for performance requirements indicated and for performance class specified below. Include a complete system for assembling components and anchoring doors.
- B. Applicable Standards: Provide windows & Doors complying with requirements of AAMA/WDMA/CSA 101/I.S.2/A440
- C. Sizes and Profiles: Required sizes for door units and profile requirements are indicated on drawings. Variable dimensions are indicated, together with maximum and minimum dimensions as required to coordinate with other work.
  1. Details shown are based upon standard details of one or more manufacturers. It is intended that similar details by other manufacturers listed will be acceptable, provided they comply with size requirements, profile limitations, and performance standards as indicated or specified.
- D. Provide thermal-break construction that has been in use for not less than three years and has been tested to demonstrate resistance to thermal conductance and condensation and to show adequate strength and security of glass retention.
- E. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.
- F. Weather Stripping: Provide operable panels with a double row of weather stripping in horizontal rails and single- or double-row weather stripping in meeting or jamb stiles, as required to meet specified performance requirements. Provide weather stripping at the perimeter of each movable panel.
  1. Provide weather stripping locked into extruded grooves in panels.

## 2.5 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for apply and designated finishes. Exposed surfaces to be free of scratches and other serious blemishes.
  1. Factory finish extruded frame components so that any part exposed to view upon completion of installation will be uniform in finish and color.
- B. High-Performance Organic Finish (Three-Coat Fluoropolymer): AA-C12C40R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: conversion coatings; Organic Coating: manufacturer's standard three-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.
  1. Color and Gloss: Custom color and gloss to match curtainwall.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Comply with manufacturer's instructions for installing frames, glass, hardware, accessories, and other components.
- B. Set product level, plumb, and true to line, without warp or rack of frames and panels. Provide proper support and anchor securely in place.
- C. Set sill members in bed of sealant or with gaskets, as indicated, to provide weathertight construction.
- D. Install glass in accordance with the recommendations of the manufacturer and the requirements specified in Division 08 Section "Glazing."
- E. Lubricate and adjust hardware to assure proper operation and maintenance.
- F. Seal perimeter joints of frames at abutting construction in accordance with the requirements specified in Division 07 Section "Sealants." Seal all joints within the system as required by the manufacturer.

### **3.2 FIELD QUALITY CONTROL**

- A. Adjust operating panels, screens, and hardware to provide a tight fit at contact points and weather stripping for smooth operation and weathertight closure. Lubricate hardware and moving parts.

### **3.3 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.

**END OF SECTION 08 12 16**

## SECTION 08 35 00 – SIDE FOLDING GRILLES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. **Section Includes:** Aluminum, manually operated, side-folding grilles.
- B. Related Sections:
  - 1. Division 05 Section "Structural Steel Framing" for structural support for track.
  - 2. Division 05 Section "Metal Fabrications" for additional steel sections for support of track, if required for a complete installation.

#### 1.3 SUBMITTALS

- A. Product Data.
- B. **Shop Drawings:** Include special conditions not detailed in Product Data. Show interface with adjacent work.
- C. **Quality Assurance/Control Submittals:**
  - 1. Provide proof of manufacturer and installer qualifications.
  - 2. Provide manufacturer's installation instructions.
- D. Closeout Submittals:
  - 1. Operation and Maintenance Manual.
  - 2. Certificate stating that installed materials comply with this specification.

#### 1.4 QUALITY ASSURANCE

- A. Qualifications:
  - 1. **Manufacturer Qualifications:** Minimum of five years' experience in producing side-folding grilles of the type specified.
  - 2. **Installer Qualifications:** Manufacturer's approval.

#### 1.5 DELIVERY STORAGE AND HANDLING

- A. Follow manufacturer's instructions.

#### 1.6 DESIGN / PERFORMANCE REQUIREMENTS

- A. Stacking:
  - 1. Minimum stacking shall be 1.05 inches/linear foot of opening plus 3.5 inches for each locking member.
  - 2. Grille support must be designed to carry the weight of a fully stacked door at any point along its length. Support is to carry the total weight / the total stacking and is express as lbs. per linear ft.
- B. **Lintel Deflection:** Accommodate deflection of lintel to prevent damage to components, deterioration of seals, or movement between door frame and perimeter framing.

- C. **Thermal Movement:** Design sections to permit thermal expansion and contraction of components to match perimeter opening construction.

## 1.7 WARRANTY

- A. **Standard Warranty:** Two years from date of shipment against defects in material and workmanship.
- B. **Maintenance:** Submit for owner's consideration and acceptance of a maintenance service agreement for installed products.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURER

- A. **Manufacturer:** Cornell, or approved equivalent.

### 2.2 FOLDING GRILLE 1

- A. **Model:** ESG32 - Glide Gard, or approved equivalent.
- B. **Curtain:**
  - 1. **Vertical Tubes:** 5/16inch diameter, 6063 T5 aluminum alloy, 3.5 inches on center.
  - 2. **Tube Spacers:** 7/16 inch outside diameter aluminum tubes to maintain horizontal chain spacing.
  - 3. **Horizontal Bars:** Aluminum bars, 6 inches x 3/4 inch (152 mm x 19 mm), Bars to be vertically spaced at 12 inches o.c. straight pattern.
  - 4. **Hinge Panels:** 2inch high continuous interlocking aluminum panels at the top and bottom of the closure.
  - 5. **Leading End Member:** 1 5/16 x 2 3/8 x 1/8inch thick extruded aluminum tube with recess for attaching curtain sections.
    - a. Provide concealed master keyable (interchangeable core), cylinder operated hook-bolt #7 member with lock operable from both sides of curtain that engages a full height wall channel. Provide rubber bumper at the edge of the locking member.
  - 6. **Intermediate Member(s):** 1 5/16 x 2 3/8 x 1/8 inch thick extruded aluminum tube with recess for attaching curtain sections.
    - a. Provide concealed master keyable (interchangeable core), cylinder operated, bottom ratcheted rod #3 member with lock operable from public side of curtain. Supply dustproof floor sockets for all drop bolts. Provide rubber bumper at the edge of the locking member.
  - 7. **Trailing End Member:** 1 5/16 x 2 3/8 x 1/8 inch thick extruded aluminum tube with recess for attaching curtain sections.
    - a. Provide self-locking #6 floating end member with an attached full height protection plate and self-locking into a steel V-stop mounted to the floor or counter inside the storage pocket.
- C. **Trolleys:** 1 1/8 inch diameter nylon tired ball bearing wheels; two wheel assembly at each hanger; three wheel assembly at all vertical members.
- D. **Track:** 1.3 x 1.8 inch thick extruded aluminum section with continuous recess for splice tongues and pins.
  - 1. Provide two (2) 90 degree curve track section(s) with a 14 inch (356 mm) radius.
- E. **Finishes:** Clear anodized

### 2.3 FOLDING GRILLE 2

- A. **Model:** ESC31 – Vista Pane Perforated, or approved equivalent.

- B. **Curtain:**
1. **Pivot Sections:** Continuous vertical interlocking aluminum members with full height butt hinges, 7 inches on center with continuous recess in edges to accept panels, top and bottom closure panels and end member connectors.
  2. **Perforated Steel Panels:** 3/16" perforated 18 gauge steel panels
    - a. Airflow Through Closure: 39%.
    - b. Airflow Through Panel: 47%.
  3. **Top and Bottom Closure Panels:** 4 inch high by 6 inch wide extruded aluminum panel shaped to fit into pivot sections and to accept trolley hanger assemblies.
  4. **Leading End Member:** 1 5/16 x 2 3/8 x 1/8 inch thick extruded aluminum tube with recess for attaching curtain sections.
    - a. Provide concealed master keyable (interchangeable core), cylinder operated hook-bolt #7 member with lock operable from public side of curtain; thumb turn cylinder lock operable from tenant side of curtain that engages a full height wall channel. Provide rubber bumper at the edge of the locking member.
  5. **Intermediate Member(s):** 1 5/16 x 2 3/8 x 1/8 inch thick extruded aluminum tube with recess for attaching curtain sections.
    - a. Provide concealed master keyable (interchangeable core), cylinder operated, bottom ratcheted rod #3 member with lock operable from public side of curtain. Supply dustproof floor sockets for all drop bolts. Provide rubber bumper at the edge of the locking member.
  6. **Trailing End Member:** 1 5/16 x 2 3/8 x 1/8 inch thick extruded aluminum tube with recess for attaching curtain sections.
    - a. Provide self-locking #6 floating end member with an attached full height protection plate and self-locking into a steel V-stop mounted to the floor or counter inside the storage pocket.
- C. **Trolleys:** 1 1/8 inch diameter nylon tired ball bearing wheels; two wheel assembly at each hanger; three wheel assembly at all vertical members.
- D. **Track:** 1.3 x 1.8 inch thick extruded aluminum section with continuous recess for splice tongues and pins.
  1. Provide 90 degree curve track section(s) with a 14 inch radius.
- E. **Finishes:** Clear anodized

## 2.4 ACCESSORIES FOR GRILLES 1 & 2

- A. **Pocket Door(s):**
1. **Door**
    - a. **Material:** A36 HR steel
    - b. **Thickness:** USS 12-gauge
    - c. **Finish:** Zirconium treatment followed by a baked-on polyester powder coat, color as selected from manufacturer's standard color range, minimum 32 color; minimum 2.5 mils cured film thickness; ASTM-D-3363 pencil hardness: H or better.
    - d. **Size:** Rough opening minus 13/16"
  2. **Frame**
    - a. **Material:** A36 HR steel
    - b. **Thickness:** USS 12-gauge steel
    - c. **Finish:** Zirconium treatment followed by a baked-on polyester powder coat, color as selected from manufacturer's standard color range, minimum 32 colors; minimum 2.5 mils (0.065 mm) cured film thickness; ASTM-D-3363 pencil hardness: H or better.
    - d. **Size:** Overlaps opening 2" with a 5/8" projection off wall
  3. **Hinges:** 3" non-mortise type
  4. **Lock:** 1" security mortise cylinder (interchangeable core)

## **2.5 FABRICATION**

- A. Fabricate with every fourth vertical rod as a hanger rod. Provide tube spacers at each hanger rod to maintain chain spacing.
- B. Hinge Panels: Continuous rows between top two and bottom two chain sets.
- C. Intermediate Members: Spacing not to exceed 13 feet on center and located at each curve.

## **2.6 OPERATION**

- A. Manual push-pull.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine header substrates upon which side-folding grilles will be installed and verify conditions are in accordance with approved shop drawings. Header, floor or sill to be level across entire grille opening.
- B. Coordinate with responsible entity to perform corrective work on unsatisfactory substrates and floor or sill levels.
- C. Commencement of work by installer is acceptance of substrate.

### **3.2 INSTALLATION**

- A. General: Install side-folding grille with necessary hardware, anchors, inserts, hangers and supports.
- B. Follow manufacturer's installation instructions.

### **3.3 ADJUSTING**

- A. Following completion of installation, including related work by others, lubricate, test, and adjust side-folding grilles for ease of operation.

### **3.4 CLEANING**

- A. Clean surfaces soiled by work as recommended by manufacturer.
- B. Remove surplus materials and debris from the site.

### **3.5 DEMONSTRATION**

- A. Demonstrate proper operation to Owner's Representative.
- B. Instruct Owner's Representative in maintenance procedures.

### **3.6 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.



1. Separate tempered glass waste for use as aggregate of nonstructural fill.
- C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
1. Aluminum
  2. Plastic Materials and Gaskets
  3. Corrugated cardboard packaging.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 08 35 00**

## **SECTION 08 41 23 – FIRE RATED STOREFRONT & DOORS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes:
  - 1. Fire rated glazing and framing systems for installation as wall sections and doors in interior openings
- B. Related Sections:
  - 1. Division 07 Section "Joint Firestopping" for perimeter fire-containment systems (safing insulation) field installed with fire-rated glazed curtain-wall systems.
  - 2. Division 07 Section "Joint Sealants" for installation of joint sealants installed with fire-rated glazed curtain-wall systems and for sealants to the extent not specified in this Section.
  - 3. Division 08 Section "Glazed Aluminum Curtain Walls" for finishes to be matched in this Section.
  - 4. Division 08 Section "Glazing" for fire rated glazing to be used in applications other than storefront.
  - 5. Division 08 Section "Door Hardware" for door hardware installed on doors in this Section.

#### **1.3 REFERENCES**

- A. American Architectural Manufacturers Association (AAMA)
  - 1. AAMA 2603-2002 Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
  - 2. AAMA 2604 -2005 Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
  - 3. AAMA 2605 -2005 Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
- B. American Society for Testing and Materials (ASTM):
  - 1. Fire safety related:
    - a. ASTM E119: Methods for Fire Tests of Building Construction and Materials.
  - 2. Material related
    - a. ASTM A 1008/A 1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength, Low Alloy, and High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable; 2007.
    - b. ASTM A 1011/A 1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength; 2006b.
  - 3. Exterior-related:
    - a. ASTM E 283-04: Test Method for Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen
    - b. ASTM E 330-02: Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference Procedure A
    - c. ASTM E 331-04: Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference

- d. ASTM E 783-02: Test Method for Field Measurement of Air Leakage through Installed Exterior Windows and Doors
  - e. ASTM E 1105-00: Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference
- C. American Welding Society (AWS)
- 1. AWS D1.3 - Structural Welding Code - Sheet Steel; 2007
- D. Builders Hardware Manufacturers Association, Inc.
- 1. BHMA A156 - American National Standards for door hardware; 2006 (ANSI/BHMA A156).
- E. National Fire Protection Association (NFPA):
- 1. NFPA 80: Fire Doors and Windows.
  - 2. NFPA 251: Fire Tests of Building Construction & Materials
  - 3. NFPA 252: Fire Tests of Door Assemblies
  - 4. NFPA 257: Fire Test of Window Assemblies
- F. Underwriters Laboratories, Inc. (UL):
- 1. UL 9: Fire Tests of Window Assemblies.
  - 2. UL 10 B: Fire Tests of Door Assemblies
  - 3. UL 10 C: Positive Pressure Fire Tests of Window & Door Assemblies
  - 4. UL 263: Fire tests of Building Construction and Materials
  - 5. UL-752 Ratings of Bullet-Resistant Materials
- G. American National Standards Institute (ANSI):
- 1. ANSI Z97.1: Standard for Safety Glazing Materials Used in Buildings
- H. Consumer Product Safety Commission (CPSC):
- 1. CPSC 16 CFR 1201: Safety Standard for Architectural Glazing Materials
- I. American Society of Civil Engineers (ASCE)
- 1. ASCE 7 – Minimum Design Loads for Buildings and Other Structures; 2005

#### **1.4 DEFINITIONS**

- A. Manufacturer: A firm that produces primary glass, fabricated glass or framing as defined in referenced glazing publications.

#### **1.5 SUBMITTALS**

- A. Product Data:
- 1. Technical Information: Submit latest edition of manufacturer's product data providing product descriptions, technical data, Underwriters Laboratories, Inc. listings and installation instructions.
- B. Shop Drawings:
- 1. Include plans, elevations and details of product showing component dimensions; framing opening requirements, dimensions, tolerances, and attachment to structure
- C. Samples. For following products:
- 1. Glass sample-as provided by manufacturer
  - 2. Sample of frame
  - 3. Verification of sample of selected finish

- D. Hardware schedule: list of manufacturer supplied hardware and verification of cylinder size complying with Division 08 Section "Door Hardware", to be supplied and installed by Fire Rated Door provider.
- E. Glazing Schedule: Use same designations indicated on drawings for glazed openings in preparing a schedule listing glass types and thicknesses for each size opening and location.
- F. Warranties: Submit manufacturer's warranty.
- G. Certificates of compliance from glass and glazing materials manufacturers attesting that glass and glazing materials furnished for project comply with requirements.
  - 1. Separate certification will not be required for glazing materials bearing manufacturer's permanent label designating type and thickness of glass, provided labels represent a quality control program involving a recognized certification agency or independent testing laboratory acceptable to authority having jurisdiction.

## 1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Qualifications according to
  - 1. International Accreditation Service for a Type A Third-Party Inspection Body (Field Services ICC-ES Third-Party Inspections Standard Operating Procedures, 00-BL-S0400 and S0401)
  - 2. International Accreditation Service for Testing Body-Building Materials and Systems
    - a. Fire Testing
      - 1) ASTM Standards E 119
      - 2) CPSC Standards 16 CFR 1201
      - 3) NFPA Standards 251, 252, 257
      - 4) UL Standards 9, 10B, 10C, 1784, UL Subject 63
      - 5) BS 476; Part 22: 1987
      - 6) EN 1634-1
      - 7) CAN Standards S 101, S 104, S 106
- B. Fire-Rated Window Assemblies: Assemblies complying with NFPA 80 that are classified and labeled by UL, for fire ratings indicated, based on testing according to NFPA 257 and UL 9.
- C. Fire-Rated Wall Assemblies: Assemblies complying with ASTM E119 that are classified and labeled by UL, for fire ratings indicated, based on testing in accordance with UL 263, ASTM E119.
- D. Listings and Labels - Fire Rated Assemblies: Under current follow-up service by Underwriters Laboratories® maintaining a current listing or certification. Label assemblies accordance with limits of manufacturer's listing.

## 1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store and handle under provisions specified by manufacturer.

## 1.8 PROJECT CONDITIONS

- A. Obtain field measurements prior to fabrication of frame units. If field measurements will not be available in a timely manner coordinate planned measurements with the work of other sections.
  - 1. Note whether field or planned dimensions were used in the creation of the shop drawings.
- B. Coordinate the work of this section with others effected including but not limited to: other interior and/or exterior envelope components and door hardware beyond that provided by this section.

## 1.9 WARRANTY

- A. Provide manufacturer's standard five-year manufacturer warranty for fire rated frames, glass and doors.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: The design for each element of the assembly is based on the product named. Subject to compliance with requirements, provide either the named product or an approved equivalent.
- B. Manufacturer Glazing Material: Provide "Pilkington Pyrostop®" fire-rated glazing as manufactured by the Pilkington Group and distributed by Technical Glass Products, or approved equivalent.
- C. Frame System: Provide "Fire frames® Aluminum Series" fire-rated frame system as manufactured and supplied by Technical Glass Products, or approved equivalent.
- D. Rated Glass Doors: "Designer Series" Doors as manufactured and supplied by Technical Glass Products, or approved equivalent.

### 2.2 PERFORMANCE REQUIREMENTS

- A. System Description:
1. Steel fire-rated glazed wall and/or window system, dual aluminum cover cap format
    - a. Face widths available:
      - 1) 2"
      - 2) Custom extruded aluminum cover caps
    - b. Duration – Walls: Capable of providing a fire rating for 120 minutes.
    - c. Duration – Doors: Capable of providing a fire rating for 90 minutes. Maximum transmitted temperature rise of 450 deg F after 30 minutes.
- B. Structural Performance
1. Design and size the system to withstand structural forces placed upon it without damage or permanent set when tested in accordance with ASTM E330 using load 1.5 times the design wind loads and of 10 seconds in duration.
  2. Accommodate movement between storefront and adjoining systems

### 2.3 MATERIALS - GLASS

- A. Fire Rated Glazing: Composed of multiple sheets of Pilkington Opti white™ high visible light transmission glass laminated with an intumescent interlayer, or an approved equivalent.
- B. Impact Safety Resistance: ANSI Z97.1 and CPSC 16CFR1201(Cat. I and II).

C. Properties Interior Glazing

	Type FR 1	Type FR 2
Fire-Rating	90 minute	120 minute
Manufacturer's designation	90-102	120-106
Glazing type	single	IGU
Nominal Thickness	1-7/16"	2-1/4" (57mm)
Weight in lbs/sf	17.61	22.9
Daylight Transmission	84%	75%
Sound Transmission Coefficient	45dB	46dB

- D. Exterior Grade: PVB inner layer installed toward exterior.
- E. Logo: Each piece of fire-rated glazing shall be labeled with a permanent logo including name of product, manufacture, testing laboratory (UL), fire rating period, safety glazing standards, and date of manufacture.
- F. Glazing Accessories: Manufacturer's standard compression gaskets, standoff, spacers, setting blocks and other accessories necessary for a complete installation.

## 2.4 MATERIALS –ALUMINUM FRAMES

- A. Aluminum Framing System – 120 min.
  - 1. Steel Frame — The steel framing members are made of two halves, nom. 1.9 in. wide (48.3 mm) with a nom. minimum depth of 1.38 in. (35 mm) with lengths cut according to glazing size.
  - 2. Aluminum Trim — Supplied with the steel framing members. Nom. 2 in. (50.8 mm) wide with a nom. depth of 1.54 in. (39 mm) with lengths cut according to glazing size.
  - 3. Stainless Steel Standoffs — Supplied with the steel framing members. Nom 5/16 in. (8 mm) diameter with a nom. minimum depth of 1 1/8 in. (28 mm) with depth adjusted to match Pilkington Pyrostop® Panel thickness.
  - 4. Stainless Steel Moment and Connecting Braces: — Supplied with the steel framing members. Nom 3/8 in. (10 mm) thick with a nom. minimum depth of 1 1/8 in. (28 mm) with depth adjusted to match Pilkington Pyrostop® Panel thickness.
  - 5. Framing Member Fasteners — Supplied with the steel framing members. Screws are M6 x16mm Button Head Socket Cap Screws for frame assembly and #6 x 1" Pan Head Sheet Metal Screws for door installation.
  - 6. Glazing Gasket —
    - a. Interior Gasketing-Supplied with the steel framing members. Nom. 3/4 in. (19 mm) x 3/16 (4.5 mm) black applied to the steel framing members to cushion and seal the glazing material when installed.
    - b. Exterior Gasketing- Supplied with the steel framing members. Nom. 2 in. (50 mm) x 3/16 (4.5 mm) black applied to the steel framing members to cushion and seal the glazing material when installed.
- B. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
  - 1. Extruded Bars, Rods, Shapes, and Tubes: ASTM B 221 (ASTM B 221M).
- C. Steel Reinforcement: With manufacturer's standard corrosion-resistant primer complying with SSPC-PS Guide No. 12.00 applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
  - 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.
- D. 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.

## 2.5 HARDWARE

- A. Operating hardware for Fire frames Designer Series Single Outswing Doors with Exit Device. Each to have the following:
  - 1. For all other hardware, see Division 08 Sections "Door Hardware" and "Door Hardware Sets."

	<b>Item</b>	<b>Description</b>	<b>Manufacturer</b>	<b>Finish*</b>
3	Hanging Devices	Weld on Pivots	Technical Glass Products	PTM
1	Exit Device	35A-F Rim	Von Duprin	626
1	Lever Trim	360 L Lever Handle	Von Duprin	626
1	Cylinder	ANSI Mortise Schlage C Keyway	Technical Glass Products	626
1	Closing Devices	TS 93 Surface Applied Closer	Dorma	689
1	Auto door Bottom	420APKL Smoke Seal	Pemko	MA
1	Weather Seal	Perimeter Gasket	Technical Glass Products	

## 2.6 ACCESSORIES

- A. Fasteners: Use fasteners fabricated from Type 304 or Type 316 stainless steel.
- B. Glazing Gaskets:
1. Glazing gaskets for interior or exterior applications: ASTM C 864 (extruded EPDM rubber that provides for silicone adhesion) or ASTM C1115 Standard Specification for Dense Elastomeric Silicone Rubber Gaskets and Accessories (extruded silicone).
- C. Intumescent Tape: As supplied by frame manufacturer.
- D. Setting Blocks: ¼" Calcium silicate.
- E. Perimeter Anchors: Steel.
- F. Silicone Sealant: One-Part Low Modulus, neutral cure High Movement-Capable Sealant: Type S; Grade NS; Class 25 with additional movement capability of 100 percent in extension and 50 percent in compression (total 150 percent); Use (Exposure) NT; Uses (Substrates) M, G, A, and O as applicable. (Use-O joint substrates include: Metal factory-coated with a high-performance coating; galvanized steel; ceramic tile.)
1. Available Products:
    - a. Dow Corning 790, 795 - Dow Corning Corp.
    - b. Momentive
    - c. Tremco
    - d. Or approved equivalent.
- G. Intumescent Caulk: Single component, latex-based, intumescent caulk designed to stop passage of fire, smoke, and fumes through fire-rated separations; permanently flexible after cure; will not support mold growth; flame spread/smoke developed 10/10.
1. Available Products:
    - a. 3M CP-25 WP+ or approved equivalent.

## 2.7 SLAG-WOOL-FIBER/ROCK-WOOL-FIBER INSULATION

- A. Available Manufacturers:
1. Fibrex Insulations Inc.
  2. Owens Corning
  3. Thermafiber.
  4. Rockwool
  5. Or approved equivalent.
- B. Unfaced, Slag-Wool-Fiber/Rock-Wool-Fiber Board Insulation: ASTM C 612, maximum flame-spread and smoke-developed indexes of 15 and 0, respectively; passing ASTM E 136 for combustion characteristics; and of the following nominal density and thermal resistivity:

1. Nominal density of 4 lb/cu. ft. (64 kg/cu. m), Types IA and IB, thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F (27.7 K x m/W at 24 deg C).
2. Fiber Color: Regular color, unless otherwise indicated.

## **2.8 FABRICATION**

- A. Obtain reviewed shop drawings prior to fabrication.
- B. Fabrication Dimensions: Fabricate fire-rated assembly to field dimensions.
- C. Factory prepared, fire-rated steel door assemblies by TGP to be prehung, prefinished with hardware preinstalled for field mounting.
- D. Field glaze door and frame assemblies.

## **2.9 FINISHES, GENERAL**

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish frames after assembly.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable. Noticeable variations in the same piece are not acceptable.

## **2.10 POWDERCOAT FINISHES**

- A. Finish after fabrication.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable. Noticeable variations in the same piece are not acceptable.
- C. Steel or Aluminum Finishes
  1. Powder-Coat Finish: Polyester Super Durable powder coating which meets AAMA 2604 for chalking and fading. Apply manufacturer's standard powder coating finish system applied to factory-assembled frames before shipping, complying with manufacturer's recommended instructions for surface preparation including pretreatment, application, and minimum dry film thickness.
  2. Color and Gloss: As selected by Architect from manufacturer's full range, including custom and metallic colors.
  3. Number of Colors Used in Project: One.
  4. Acceptable Manufacturers:
    - a. Tiger Drylac
    - b. Or approved equivalent.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Site Verification of Conditions: Verify substrate conditions (which have been previously installed under other sections) are acceptable for product installation in accordance with manufacturer's instructions. Verify openings are sized to receive curtain wall system and sill plate is level in accordance with manufacturer's acceptable tolerances.
- B. Notify Architect of any conditions which jeopardize the integrity of the proposed fire wall / door system.
- C. Do not proceed until such conditions are corrected.



### **3.2 INSTALLATION**

- A. See Fire frames Aluminum Series Installation Manual.

### **3.3 REPAIR AND TOUCH UP**

- A. Powder Coated Finishes
  - 1. Limited to minor repair of small scratches. Use only manufacturer's recommended products. Such repairs shall match original finish for quality or material and view.
  - 2. Repairs and touch-up not visible from a distance of 5 feet Owner and Architect to approve.
- B. Remove and replace glass that is broken, chipped, cracked, abraded, or damaged.

### **3.4 PROTECTION AND CLEANING**

- A. Protect 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.
  - 1. Do not clean with astringent cleaners. Use a clean "grit free" cloth and a small amount of mild soap and water or mild detergent.
  - 2. Do not use any of the following:
    - a. Steam jets
    - b. Abrasives
    - c. Strong acidic or alkaline detergents, or surface-reactive agents
    - d. Detergents not recommended in writing by the manufacturer
    - e. Do not use any detergent above 77 degrees F
    - f. Organic solvents including but not limited to those containing ester, ketones, alcohols, aromatic compounds, glycol ether, or halogenated hydrocarbons.
    - g. Metal or hard parts of cleaning equipment must not touch the glass surface
- B. 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 them immediately as recommended by glass manufacturer.
- C. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended by glass manufacturer.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
  - 1. Separate tempered glass waste for use as aggregate of nonstructural fill.
- C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 08 41 23**

## **SECTION 08 41 26 - ALL-GLASS ENTRANCES AND STOREFRONTS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Interior swinging all-glass entrance doors.
  - 2. Interior all-glass storefronts.
- B. Related Sections:
  - 1. See Division 07 Section "Joint Sealants" for pre-compressed, self-expanding foam joint sealant used in this section.
  - 2. See Division 08 Section "Glazing" for glass used with this section.

#### **1.3 REFERENCES**

- A. AAMA 611-98 - Voluntary Standards for Anodized Architectural Aluminum
- B. IBC Section 2403.3 – Deflection of Framing Members Supporting Individual Glass Panes
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- D. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements

#### **1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for all-glass system.
  - 2. For sealants, indicating VOC content.
  - 3. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.
- B. Shop Drawings: For all-glass entrances and storefronts.
  - 1. Include plans, elevations, and sections.
  - 2. Include details of fittings and glazing, including isometric drawings of patch fittings and rail fittings.
  - 3. Door hardware locations, mounting heights, and installation requirements.
- C. Samples for Initial Selection: For each type of exposed finish indicated.
- D. Samples for Verification: For each type of exposed finish indicated, prepared on Samples of size indicated below.
  - 1. Metal Finishes: **6-inch**- long sections of patch and rail fittings, accessory fittings, and other items.
  - 2. Glass: **6 inches** square, showing exposed-edge finish.

3. Door Hardware: For exposed door hardware of each type, in specified finish, full size.

E. Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate final door hardware schedule with doors sidelights, transoms, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

## **1.6 INFORMATIONAL SUBMITTALS**

A. Qualification Data: For Installer.

B. Sample Warranty: For warranty.

## **1.7 CLOSEOUT SUBMITTALS**

A. Maintenance Data: For all-glass systems to include in maintenance manuals.

## **1.8 QUALITY ASSURANCE**

A. Product Source: for consistency of quality and construction, all aluminum-framed glass walls and demountable panels should be supplied by a single source.

B. Installation:

1. Installers shall be approved "factory certified" by the manufacturer.
2. When approved installers are not available, installation should be by manufacturer's trained personnel.

C. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication to ensure proper fitting of the work.

D. Mechanical Strength of Partitions: provide partitions capable of withstanding static loads in accordance with ANSI/BIFMA X5.6.

E. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.

1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

F. Mockup: Install glass wall, door and all hardware on Group Study Room 230 to serve as mockup for Architect's approval before proceeding with other installations.

## **1.9 WARRANTY**

A. Warranty: Manufacturer agrees to repair or replace components of all-glass systems that do not comply with requirements or 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 PERFORMANCE REQUIREMENTS**

A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design all-glass entrances and storefronts.

- B. General Performance: Comply with performance requirements specified, as determined by testing of all-glass entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- A. Structural Performance: ALUR Glass Wall System complies with Section 2403.3 of the 2015 International Building Code and limits the deflection of framing members supporting individual glass panes to the smaller of L/175 or 0.75".
- B. Sound Transmission Loss: ASTM E90
  - 1. Glass Panels: 36 STC (1/2" Tempered Glass)
- C. Fire Rating: ASTM E84
  - 1. Glass: Non-Combustible

## 2.2 MANUFACTURERS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide Alur glass wall systems by the following manufacturer, or approved equivalent.
  - 1. Alur Walls by Modular Architectural Interiors, LLC.

## 2.3 METAL COMPONENTS

- A. Aluminum Framing: Aluminum extrusions, 6063-T5 aluminum alloy.
  - 1. Finish: PVDF resin finish.
    - a. Custom color to match Architect's sample.
- B. Top Frame: aluminum extrusions made up of ceiling track and top frame sleeve connected with hexagonal standoffs to offer height adjustability.
  - 1. Gaskets, Polyvinyl chloride, CAS No. 9002-86-2, to grip glass modules
  - 2. Width: 1-5/16" (34 mm)
  - 3. Height: 2-1/2" (63.5 mm); additional 0.3546" (9 mm) extension
  - 4. Length: As indicated on drawings.
- C. Bottom Frame: C-channel aluminum extrusion with gaskets to grip glass modules.
  - 1. Width: 1" (25 mm); CA Bottom Frame: 1-1/8" (28.5 mm)
  - 2. Height: 1-3/16" (30 mm) CA Bottom Frame: 1-7/16" (36.5 mm)
  - 3. Length: As indicated on drawings.
- D. End Post: aluminum extrusion used as beginning or end of wall run.
  - 1. Thickness: 1-7/16" (36.5 mm)
  - 2. Width: 2-1/2" (63.5 mm)
- E. Door Post: aluminum extrusion to support door
  - 1. Thickness: 1-7/16" (36.5 mm)
  - 2. Width: 2-1/2" (63.5 mm)
- F. T Post: aluminum extrusion to connect glass front wall with glass nib wall into drywall for T connection, if required.
  - 1. Thickness: 1-7/16" (36 mm)
  - 2. Width: 1-7/16" (36 mm)

## 2.4 GLAZING

- A. See Division 08 Section "Glazing" for GL 8 glazing type to be used with All-Glass Entrances & Storefronts.

- B. Glass-to-Glass Connections: Translucent polycarbonate (93% clear resin) butt joint for I, L, T and 135-degree connections. Matching clear polycarbonate door seals (woven cloth gasket) available for sliding door when used without posts.

## **2.5 DOOR HARDWARE**

- A. Patch Fitting:
  - 1. Auto Patch Closer: Hydraulic door closer for pivot door with matching top patch and hold open feature. Hydraulic closer mechanism housed inside patch – no floor penetration or cutting.
  - 2. Top Aligned Ladder Pull: Non-locking option.
- B. Finish: Brushed stainless steel.

## **2.6 ACCESSORIES**

- A. Polyethylene foam tape for acoustical seal.

## **2.7 FINISHES**

- A. Protect finishes on exposed surfaces from damage during shipping.
- B. Appearance of Finished Work:
  - 1. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of manufacturer's benchmark sample.
  - 2. Noticeable variations in the same piece are not acceptable.
  - 3. Variations in appearance of other components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine project conditions and verify that the work of this section may properly commence.
- B. Do not begin installation until surfaces have been properly prepared. If surface preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Ensure finished floor under glass partition is level +/- 1/4" in 5' (non-cumulative).
- D. Verify concealed overhead structural supports are sized and located properly.

### **3.2 PREPARATION**

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the surfaces under the project conditions.

### **3.3 INSTALLATION**

- A. Use only certified/skilled craftsmen for work to be done in accordance with the manufacturer's installation instructions and/or approved shop drawings and specifications.

- B. Install system rigid, level, plumb and aligned. Securely anchor frames to surfaces with fasteners recommended by manufacturer. Accurately fit and fasten cover to abutting surfaces. Shim under glass inside bottom frame at uneven floors to ensure leveled installation.
- C. Fasten tracks to floors and overhead gypsum partitions according to drawings. At top, mechanically affix top tracks into previously installed solid blocking behind gwb. On floors, mechanically affix to slab above floor covering or directly into cement slab.
- D. Install partition components in accordance with approved shop drawings.
- E. Install seals to prevent light and sound transmission at connections to floors, ceilings, fixed walls and abutting surfaces.
- F. Install polyethylene foam tape at all perimeter jamb, head and sill conditions where storefront system meets adjacent materials.
- G. Install pre-compressed self-expanding foam joint sealant between jambs and recessed aluminum wall base.
  - 1. Recess foam seal from face of jamb on both sides of glass wall system. See Drawings.
- H. The glass panels in accordance with manufacturer's written instructions.
- I. Sealed panels with the insertion of polycarbonate joints are supplied by supplier.
- J. Install doors and frames, glazing, and glazing frame assemblies securely anchored to partitions and with doors aligned and fitted.
- K. Install and adjust door hardware for proper operation.

### **3.4 PROTECTION AND CLEANING**

- A. Protect installed products until completion of project.
- B. Touch-up, repair or replace damaged products before substantial completion.
- C. After completion of installation, all systems shall be inspected, adjusted and left in working order.
- D. After installation and adjusting clean metal and glass surfaces to remove dust, loose fibers, fingerprints, adhesives, and other foreign materials.
- E. After cleaning, all work shall be protected against damage until it is accepted by the General Contractor.
- F. Thereafter, it shall be the responsibility of the General Contractor to maintain protection and provide final cleaning.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Steel.
  - 3. Plastic Materials

4. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
1. Treated, stained, painted or contaminated wood.

**END OF SECTION 08 41 26**

## **SECTION 08 42 13 - ALUMINUM ENTRANCE DOORS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Manual-swing entrance doors.
- B. Related Requirements:
  - 1. Division 08 Section "Aluminum Frames" for interior aluminum framing.
  - 2. Division 08 Section "Door Hardware" for hardware to be installed on entrance and exit doors, and for automatic door operators.
  - 3. Division 08 Section "Glazing" for glazing to be stopped into entrance doors and frames.
  - 4. Division 08 Section "Glazed Aluminum Curtain Walls" for glazing systems that will receive aluminum doors and frames specified in this section, and for coordination of finishes.
  - 5. See Electrical Drawings for power and wiring associated with door operators, security card readers, door contacts, door actuators, and electrical hold open devices.

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For aluminum-framed entrance doors.
  - 1. Include details of door construction and attachment to adjacent building components.
  - 2. Include point-to-point wiring diagrams showing the following:
    - a. Power requirements for each electrically operated door hardware.
    - b. Location and types of switches, signal device, conduit sizes, and number and size of wires.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Fabrication Sample: Provide corner sample of door showing construction.
- F. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.



- B. Energy Performance Certificates: For aluminum-framed entrances, accessories, and components, from manufacturer.
  - 1. Basis for Certification: NFRC-certified energy performance values for each aluminum-framed entrance.
- C. Product Test Reports: For aluminum-framed entrances.
- D. Sample Warranties: For special warranties.

## 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed entrances to include in maintenance manuals.

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
  - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

## 1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Two years from date of Substantial Completion.
- B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. **Manufacturers:** Provide products by the manufacturer listed below, or an approved equivalent:
  - 1. [Kawneer North America, an Arconic company.](#)
- B. Source Limitations: Obtain all components of aluminum-framed entrance, including framing and accessories, from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
  - 1. Entrance Doors:
    - a. Maximum air leakage of 1.6psf at a static-air-pressure differential of 0.30 cfm/ft<sup>2</sup>.

- B. Energy Performance: Certify and label energy performance according to NFRC as follows:
  - 1. Thermal Transmittance (U-factor):
    - a. Medium Stile Doors: Fixed glazing and framing areas shall have U-factor of not more than 0.61 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
    - b. Narrow Stile Doors: Fixed glazing and framing areas shall have U-factor of not more than 0.59 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
- C. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

### **2.3 ENTRANCE DOORS**

- A. Entrance Doors: Provide manufacturer's standard glazed entrance doors for manual-swing or automatic operation.
  - 1. Basis of Design: Kawneer Standard Entrance 350 Swing Door, Medium Stile, or approved equivalent.
  - 2. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch-thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
  - 3. Door Design: Medium stile; 3-1/2-inch nominal width.
  - 4. Bottom Rail: Provide 10" high bottom door rail to meet ADA requirements.
  - 5. Glazing Stops and Gaskets: Square, Snap-On, extruded-aluminum stops and preformed gaskets.
    - a. Provide nonremovable glazing stops on outside of door.

### **2.4 ENTRANCE DOOR HARDWARE**

- A. Entrance Door Hardware is specified in Division 08 Sections "Door Hardware" and "Door Hardware Sets."

### **2.5 GLAZING**

- A. Glazing: Comply with Division 08 Section "Glazing."
  - 1. Doors to receive 1" IGU as specified in above section.
- 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.

### **2.6 ACCESSORIES**

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
  - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
  - 2. Reinforce members as required to receive fastener threads.
  - 3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system.

### **2.7 FABRICATION**

- A. Form or extrude 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. 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. Physical and thermal isolation of glazing from framing members.
  - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
  - 5. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door 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.
- E. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
  - 1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
  - 2. At exterior doors, provide weather sweeps applied to door bottoms.
- F. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- G. 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 fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - 1. Color and Gloss: Match Architect's sample.
  - 2. Number of Colors: Two, to match adjacent aluminum curtain wall.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. General:
  - 1. Comply with manufacturer's written instructions.
  - 2. Do not install damaged components.
- B. Install components plumb and true in alignment with established lines and grades.

- C. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
  - 1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
  - 2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

### **3.3 ERECTION TOLERANCES**

- A. Erection Tolerances: Install aluminum doors to comply with the following maximum tolerances:
  - 1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet
  - 2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
  - 3. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

### **3.4 MAINTENANCE SERVICE**

- A. Entrance Door Hardware:
  - 1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.
  - 2. Initial Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of entrance door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper entrance door hardware operation at rated speed and capacity. Use parts and supplies that are the same as those used in the manufacture and installation of original equipment.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
  - 1. Separate tempered glass waste for use as aggregate of nonstructural fill.
- C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Stainless steel.
  - 3. Plastic Materials
  - 4. Corrugated cardboard packaging.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 08 42 13**

## **SECTION 08 44 13 – GLAZED ALUMINUM CURTAIN WALLS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Type 1: Conventionally glazed aluminum curtain walls installed as stick assemblies, with fiberglass pressure plate for increased thermal performance.
  - 2. Type 2: Field-glazed, two-sided structural-sealant-glazed curtain wall assemblies, with fiberglass pressure plate for increased thermal performance.
  - 3. Type 3: Curtain wall assembly for punched openings.
  - 4. Custom extruded aluminum sunscreen louvers individually anchored to aluminum curtain wall assemblies.
  - 5. Prefinished aluminum nosing and trim attached to curtain wall.
  - 6. Miscellaneous aluminum extrusions and anchors affixed to curtain wall to support glass fins.
- B. Related Sections:
  - 1. Miscellaneous aluminum extrusions affixed to curtain wall shall comply with this Section and with Division 5 Section "Decorative Metal."
  - 2. Division 07 Section "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain walls and for sealants to the extent not specified in this Section.
  - 3. Division 07 Section "Fluid-Applied Membrane Air Barriers" for work associated with joints between air and vapor barriers and curtain walls.
  - 4. Division 07 Section "Thermal Insulation" for insulation behind glass spandrel panels.
  - 5. Division 08 Section "Aluminum-Framed Entrances" for aluminum entrance door assemblies and storefront systems, and for coordinating finishes among aluminum fenestration units.
  - 6. Division 08 Section "Sloped Glazing Assemblies" for sloped glazing with finish to match curtain wall.
- A. Definitions
  - 1. Definitions: For fenestration industry standard terminology and definitions refer to American Architectural Manufacturers Association (AAMA) – AAMA Glossary (AAMA AG).

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. General Performance: Comply with performance requirements specified, as determined by testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
  - 1. Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
    - a. Design glazed aluminum curtain walls to maintain clearances at openings, to allow for construction tolerances, and to accommodate deflection of primary building structure as follows:
      - b. Upward and downward movement of 1/4".
  - 2. Failure also includes the following.
    - a. Thermal stresses transferring to building structure.
    - b. Glass breakage.
    - c. Loosening or weakening of fasteners, attachments, and other components.

- B. Delegated Design: Design glazed aluminum curtain walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Structural Loads:
1. Wind Loads: criteria as indicated on Contract Drawings.
- D. Structural-Test Performance: Test according to ASTM E 330 and TAS 202 as follows:
1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits. (L/175 of clear span)
  2. A static air design load of 40 psf shall be applied in the positive and negative direction.
    - a. When tested at 150% of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.2% of span.
    - b. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- E. Deflection of Framing Members: At design wind pressure, as follows:
1. Deflection Normal to Wall Plane: Limited to edge of glass in a direction perpendicular to glass plane not exceeding L/175 of the glass edge length for each individual glazing lite, 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
  2. Deflection Parallel to Glazing Plane: Limited to L/360 of clear span or 1/8 inch, whichever is smaller.
  3. Cantilever Deflection: Where framing members overhang an anchor point, limit deflection to two times the length of cantilevered member, divided by 175.
- F. Story Drift: Accommodate design displacement of adjacent stories indicated.
1. Design Displacement: L/400 .
  2. Test Performance: Meeting criteria for passing based on building occupancy type when tested according to AAMA 501.4 at design displacement and 1.5 times the design displacement.
- G. Air Infiltration: The test specimen shall be tested in accordance with ASTM E 283. Air infiltration rate shall not exceed 0.06 cfm/ft<sup>2</sup> (0.3 l/s · m<sup>2</sup>) at a static air pressure differential of 6.2 psf (300 Pa).
- H. Water Resistance, (static): The test specimen shall be tested in accordance with ASTM E 331. There shall be no leakage at a static air pressure differential of 12 psf (575 Pa) as defined in AAMA 501.
- I. Water Resistance, (dynamic): The test specimen shall be tested in accordance with AAMA 501.1. There shall be no leakage at an air pressure differential of 12 psf (575 Pa) as defined in AAMA 501.
- J. Energy Performance: Glazed aluminum curtain walls shall have certified and labeled energy performance ratings in accordance with NFRC.
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than the following, as determined according to NFRC 100.
    - a. Type 1:
      - 1) When glazed with UGI 1, 3, 4 or 5 (Winter Night U=0.25, Summer Day U=0.21)
        - a) System U-value is **0.37** Btu/sq. ft. x h x deg F
    - b. Type 2:
      - 1) When glazed with UGI 3 or 4 (Winter Night U=0.25, Summer Day U=0.21)
        - a) System U-value is **0.36** Btu/sq. ft. x h x deg F
    - c. Type 3:

- 1) When glazed with UGI 1 or 2 (Winter Night U=0.25, Summer Day U=0.21)
    - a) System U-value is **0.32** Btu/sq. ft. x h x deg F
  2. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 0.60 cfm/sq. ft. of fixed wall area as determined according to ASTM E 283 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft..
  3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than the following, as determined according to NFRC 500.
    - a. Type 1: Frame CR = 0.76 or better.
    - b. Type 2: Frame CR = 0.77 or better.
    - c. Type 3: Frame CR = 0.74 or better.
- K. Sound Transmission Loss: When tested to ASTM E90, the Sound Transmission Class (STC) shall not be less than 31 and the outdoor-indoor transmission class (OITC) shall not be less than 25 based upon 1" (25.4) laminated glass (1/4" laminated, 1/2" AS, 1/4" laminated).
- L. Structural Sealant: Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed curtain walls without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
  1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
  2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate because sealant-to-substrate bond strength exceeds sealant's internal strength.
- M. Structural Sealant Joints:
  1. Designed to carry gravity loads of glazing.
  2. Designed to produce tensile or shear stress of less than 20 psi.
  3. Design reviewed and approved by structural-sealant manufacturer.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Letter of Verification of Compatibility for Extruded Silicone Air and Vapor Barrier Transition:
  1. Provide letter to verify compatibility of products in this section which come into contact with those listed in the following sections, as shown in the Architectural Drawings:
    - a. Division 07 Section "Fluid-Applied Membrane Air Barriers."
    - b. Division 07 Section "Fluid Applied Insulation Coating."
    - c. Division 07 Section "Pre-Applied Sheet Membrane Waterproofing."
    - d. Division 07 Section "Self-Adhering Sheet Waterproofing."
    - e. Division 07 Section "Thermal Insulation," especially spray applied.
    - f. Division 07 Section "Applied Fireproofing."
    - g. Division 07 Section "Polyvinyl-Chloride (PVC) Roof."
    - h. Division 07 Section "Sheet Metal Flashing & Trim."
    - i. Division 07 Section "Flexible Stainless Steel Flashing."
  2. Provide additional testing as required to verify compatibility.
- C. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
  1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
  2. Include structural analysis calculations signed and sealed by the qualified professional engineer (registered in the state of New Jersey) responsible for their preparation.
  3. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:

- a. Joinery, including concealed welds.
  - b. Anchorage.
  - c. Expansion provisions.
  - d. Glazing.
  - e. Sunshades.
  - f. Aluminum channels and trim and anchorages to curtain walls.
  - g. Glass fins.
  - h. Flashing and drainage.
- D. Samples for Initial Selection: For units with factory-applied color finishes.
- E. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- F. Fabrication Samples: Comprised of full sized components showing details of the following:
- 1. Horizontal aluminum sun shade fin and attachment to mullion assembly.
  - 2. Vertical glass fin and attachment to mullion assembly.
  - 3. 12" long corner assembly of all custom nosing caps
- G. Delegated-Design Submittal: For glazed aluminum curtain walls indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- H. Qualification Data: For qualified Installer.
- I. Seismic Qualification Certificates: For glazed aluminum curtain walls, accessories, and components, from manufacturer.
- 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
- J. Welding certificates.
- K. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components, from manufacturer.
- 1. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.
- L. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified preconstruction testing agency, for glazed aluminum curtain walls, indicating compliance with performance requirements.
- M. Field quality-control reports.
- N. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.
- O. Warranties: Sample of special warranties.

## **1.5 QUALITY ASSURANCE**

- A. Installer Qualifications: Capable of assuming engineering responsibility and performing work of this Section and who is acceptable to manufacturer:
- 1. Engineering Responsibility: Prepare data for aluminum-framed systems, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in systems similar to those indicated for this Project and submission of reports of tests performed on manufacturer's standard assemblies.



- B. **Manufacturer Qualifications:** A manufacturer capable of fabricating glazed aluminum curtain walls that meet or exceed energy performance requirements indicated and of documenting this performance by certification, labeling, and inclusion in lists.
- C. **Quality Control Program for Structural-Sealant-Glazed System:** Develop quality control program specifically for Project. Document quality-control procedures and verify results for aluminum framed systems. Comply with ASTM C 1401 recommendations including, but not limited to, system material-qualification procedures, preconstruction sealant-testing program, procedures for system fabrication and installation, and intervals of reviews and checks.
- D. **Product Options:** Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
  - 1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.
  - 2. Manufacturer shall not modify framing depths from those indicated. If required, manufacturer shall provide internal steel reinforcement of curtain wall members to meet Performance Requirements.
  - 3. Manufacturer shall not revise direction or orientation of primary framing members as indicated.
  - 4. Manufacturer shall not modify indicated attachment methods of curtain wall framing or support to adjacent construction.
- E. **Preconstruction Sealant Testing:** For structural-sealant-glazed systems, perform sealant manufacturer's standard tests for compatibility with and adhesion of each material that will come in contact with sealants and each condition required by aluminum-framed systems.
  - 1. Test a minimum of five samples each of metal, glazing and other material.
  - 2. Prepare samples using techniques and primers required for installed systems.
  - 3. Perform tests under environmental conditions that duplicate those under which assemblies will be installed.
  - 4. For materials that fail tests, determine corrective measures necessary to prepare each material to ensure compatibility with and adhesion of sealants including, but not limited to, specially formulated primers. After performing these corrective measures on the minimum number of samples required for each material, retest materials.
- F. **Source Limitation for Aluminum-Framed Systems:** Obtain all curtain wall, storefront, entrances and windows from single source manufacturer.
- G. **Structural-Sealant Glazing:** Comply with ASTM C 1401, "Guide for Structural Sealant Glazing" for design and installation of structural-sealant-glazing systems.
- H. **Structural-Sealant Joints:** Design reviewed and approved by structural-sealant manufacturer.
- I. **Welding Qualifications:** Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
- J. **Energy Performance Standards:** Comply with NFRC for minimum standards of energy performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
- K. **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 mockup of typical wall area for each type of glazed aluminum curtain wall and glazing. Glazed aluminum curtain wall mockup shall be incorporated into freestanding construction of mockup of adjacent building construction materials.

2. Documentation of mockup scope will be issued at a later date.
3. Field testing shall be performed on mockups according to requirements in "Field Quality Control" Article.
4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
5. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

L. Preinstallation Conference: Conduct conference at Project site.

M. Air Barrier System Preinstallation Conference: Participate in conference at Project Site. Requirements for conference are described in Division 07 Section "Fluid-Applied Membrane Air Barriers."

## 1.6 PROJECT CONDITIONS

A. Field Measurements: Verify actual locations of structural supports for glazed aluminum curtain walls by field measurements before fabrication and indicate measurements on Shop Drawings.

## 1.7 WARRANTY

A. Special Assembly Warranty: Standard form in which manufacturer agrees to repair or replace components of glazed aluminum curtain walls that do not comply with requirements or that fail in materials or workmanship 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 created by wind and thermal and structural movements.
  - c. Deterioration of metals and other materials beyond normal weathering.
  - d. Water penetration through fixed glazing and framing areas.
  - e. Failure of operating components.
2. Warranty Period: Two years from date of Substantial Completion.

B. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.

1. Deterioration includes, but is not limited to, the following:
  - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
  - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
  - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
2. Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

A. Basis-of-Design Product: The design of the glazed aluminum curtain wall assembly is based on the following systems as manufactured by Kawneer North America; an Alcoa company. Provide the curtain wall systems listed below, or an approved equivalent.

1. Type 1: Series 1600 Wall System 1, with fiberglass pressure plate.
2. Type 2: Series 1600 Wall System 2, with fiberglass pressure plate.
3. Type 3: Clearwall Curtain Wall System SSIT, screw spline, outside glazed with metal interfaced insulating glass.

### 2.2 MATERIALS

A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.

1. Sheet and Plate: ASTM B 209.
  2. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
  3. Extruded Structural Pipe and Tubes: ASTM B 429.
  4. Structural Profiles: ASTM B 308/B 308M.
  5. Welding Rods and Bare Electrodes: AWS A5.10/A5.10M.
- B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
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.

## 2.3 FRAMING

- A. Framing Members: Manufacturer's standard extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Construction: Thermally broken.
  2. Mullion Sizes: As indicated on Drawings.
  3. Glazing System: Retained mechanically with gaskets on four sides.
    - a. Type 1: Outside glazed pressure plate format.
    - b. Type 2: Outside glazed 2-sided structural silicone glazed (SSG) format.
    - c. Type 3: Retained mechanically with toggles on four sides.
  4. Glazing Plane: Front.
- 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. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
  2. Reinforce members as required to receive fastener threads.
  3. Use exposed fasteners with countersunk Phillips screw heads, finished to match framing system, fabricated from 300 series stainless steel.
  4. Toggle Assembly: Toggle assembly as tested by manufacturer.
- D. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
  2. Provide special anchors or attachments where indicated and at other locations where attachment will remain exposed to view.
- E. Concealed 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.
- F. Framing Sealants: Manufacturer's standard sealants.

## 2.4 GLAZING

- A. Glazing: Comply with 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: For structural-sealant-glazed curtain walls, as recommended by manufacturer for joint type, and as follows:
  - 1. Structural Sealant: ASTM C 1184, chemically curing silicone formulation that is compatible with system components with which it comes in contact, specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in curtain-wall assembly indicated.
    - a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 100 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    - b. Color: As selected by Architect from manufacturer's full range of colors.
  - 2. Weatherseal Sealant: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed curtain-wall manufacturers for this use.
    - a. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
    - b. Color: Matching structural sealant.

## 2.5 INSULATED METAL-FACED SPANDREL PANELS

- A. Insulated Spandrel Panels: Laminated, metal-faced flat panels with no deviations in plane exceeding 0.8 percent of panel dimension in width or length.
  - 1. Overall Panel Thickness: **1 inch**.
  - 2. Exterior Skin: Aluminum.
    - a. Thickness: Manufacturer's standard for finish and texture indicated.
    - b. Finish: Matching framing system.
    - c. Texture: Smooth.
    - d. Backing Sheet: Manufacturer's standard.
  - 3. Interior Skin: Aluminum.
    - a. Thickness: Manufacturer's standard for finish and texture indicated.
    - b. Finish: Matching curtain-wall framing where exposed, manufacturer's option where concealed.
    - c. Texture: Smooth.
    - d. Backing Sheet: Manufacturer's standard.
  - 4. Thermal Insulation Core: Manufacturer's standard rigid, closed-cell, polyisocyanurate board.

## 2.6 PREFINISHED ALUMINUM TRIM

- A. Custom Sunscreen Louvers: Prefinished custom extruded aluminum louver fins individually anchored to aluminum curtain wall assemblies with clips, as shown in Drawings.
- B. Exterior and Interior Extruded Aluminum Trim: Prefinished aluminum sections as indicated on Drawings to match finish and color of curtain wall. Profiles as drawn or otherwise required. All fasteners for attachment to be concealed.

## 2.7 ACCESSORY MATERIALS

- A. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.
- B. Gaskets: Glazing gaskets shall comply with ASTM C 864 and be extruded of a silicone compatible EPDM rubber that provides for silicone adhesion.

- C. Pressure Plate: Fiberglass pressure cap for increased thermal performance of system.
- D. Thermal Break: Dense EPDM thermal separator.
- E. Neoprene gaskets between curtain wall and aluminum trim.
- F. Versoleil™ SunShade outrigger, or approved equivalent, customized to accept exterior glass fins. Outriggers are anchored directly to the vertical curtain wall mullions. Anchors shall receive custom finish to match curtain wall.
- G. Extruded Silicone Air and Vapor Barrier Transitions: Extruded silicone assemblies engineered to provide continuity of air and vapor barrier at perimeter of aluminum framing members. Provide the following assemblies as manufactured by Tremco, Ashland, OH, or approved equivalent.
  - 1. Proglaze ETA - Systems 1, 2 and 3.
  - 2. Pre-engineered, silicone extrusion, with integral dart and/or single or double rib extruded sheet. The system assembly is adhesively sealed with Spectrem 1 to the window assembly to provide an airtight and waterproof seal to the structure. The engineered transitions may be comprised of the following components:
    - a. Silicone Rubber Sheet (SRS): Extruded, 40 durometer translucent silicone sheet.
    - b. Silicone Transition Profiles: Three dimensional injected molded profiles should be used where appropriate.
    - c. Silicone Rubber Extrusion (SRE): Extruded, 40 durometer translucent silicone with lock-in dart.
    - d. Metal adaptor to accept Silicone Rubber Extrusion.
    - e. Silicone Sealants: Comply with ASTM C920, single-component, neutral-curing silicone; Class 100/50, Grade NS, Use O. Product shall be: Spectrem 1 as manufactured by Tremco, or approved equivalent.
  - 3. Verify compatibility of substrates to receive extruded silicone air and vapor barrier transitions to assure proper adhesion prior to start of work. Coordinate with General Prime Contractor.
- H. Insulation: See Division 07 Section "Insulation".
- I. Prefinished aluminum sheet metal panning to be installed on inside face of insulation at glass spandrel locations.

## **2.8 FABRICATION**

- A. Form or extrude aluminum shapes before finishing.
- B. 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.
  - 3. Physical and thermal isolation of glazing from framing members.
  - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
  - 5. Provisions for field replacement of glazing from exterior.
  - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- C. Fabricate components that, when assembled, have the following characteristics:
  - 1. Internal guttering system or other means to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
  - 2. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.

- D. Curtain Wall Framing: Fabricate components for assembly using shear block system following manufacturer's standard installation instructions.
- E. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

## **2.9 ALUMINUM FINISHES**

- A. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  - 1. Color and Gloss: As selected by Architect from manufacturer's full range of standard and custom metallic colors and gloss levels.
  - 2. Number of Colors: There will be three (3) colors used for items specified in this section.

## **2.10 SOURCE QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to evaluate glazed aluminum curtain wall systems.
- B. Structural-Sealant-Glazed Systems: Perform quality-control procedures complying with ASTM C 1401 recommendations, including, but not limited to, system material-qualification procedures, sealant testing, and system fabrication reviews and checks.
- C. Structural-sealant-glazed system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. General:
  - 1. Comply with manufacturer's written instructions.
  - 2. Do not install damaged components.
  - 3. Fit joints to produce hairline joints free of burrs and distortion.
  - 4. Rigidly secure nonmovement joints.
  - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
  - 6. Weld components in concealed locations to minimize distortion or discoloration of finish. Protect glazing surfaces from welding.
  - 7. 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 glazed aluminum curtain wall to exterior.
- D. Install components plumb and true in alignment with established lines and grades.
- E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
- F. Install glazing as specified in Division 08 Section "Glazing."
- G. Install custom extruded sunscreen louver fins to clips secured to curtain wall glazing caps in accordance with manufacturer's engineering analysis, approved shop drawings and instructions.

### **3.3 ERECTION TOLERANCES**

- A. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:
  1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
  2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
  3. Alignment:
    - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
    - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
    - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
  4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

### **3.4 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of representative areas of glazed aluminum curtain walls shall take place as installation proceeds to determine compliance of installed assemblies with specified requirements.
  1. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article, but not more than 0.50 cfm/sq. ft., of fixed wall area when tested according to ASTM E 783 at a minimum static-air-pressure differential of 1.57 lbf/sq. ft..
    - a. Test Area: One bay wide, but not less than 30 feet, by one story of glazed aluminum curtain wall.
    - b. Perform a minimum of four tests in areas as directed by Architect. One test area for each type of curtain wall installed.
  2. Water Penetration: Areas shall be tested according to ASTM E 1105 at a minimum uniform static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.
    - a. Test Area: One bay wide, but not less than 30 feet, by one story of glazed aluminum curtain wall.
    - b. Perform a minimum of four tests in areas as directed by Architect. One test area for each type of curtain wall installed.
  3. Water Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
    - a. Test Area: A minimum area of 75 feet by one story of glazed aluminum curtain wall.

- C. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Manufacturer's Field Services: Upon Owner's written request, provide periodic site visit by manufacturer's field service representative.

### **3.5 ADJUSTING, CLEANING AND PROTECTION**

- A. Protection: Protect installed product's finish surfaces from damage during construction. Protect aluminum curtain wall system from damage from grinding and polishing compounds, plaster, lime, acid, cement, or other harmful contaminants.
- B. Cleaning: Repair or replace damaged installed products. Clean installed products in accordance with manufacturer's instructions prior to owner's acceptance. Remove construction debris from project site and legally dispose of debris.
- C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.

### **3.6 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
  - 1. Separate tempered glass waste for use as aggregate of nonstructural fill.
- C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- D. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 08 44 13**



## **08 44 33 – SLOPED GLAZING ASSEMBLIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes:
  - 1. Engineering and drafting of production documents, including structural calculations of the entire skylight system.
  - 2. Fabrication and erection of skylight frames and glazing.
  - 3. Skylight related flashings.
- B. Related Sections include:
  - 1. Division 05 Section "Structural Steel Framing."
  - 2. Division 05 Section "Metal Fabrications."
  - 3. Division 07 Section "Sheet Metal Flashing & Trim."
  - 4. Division 08 Section "Glazing" for glass installed in sloped glazing assembly specified here.
  - 5. Division 07 Section "PVC Roofing."
  - 6. Division 07 Section "Sealants."

#### **1.3 REFERENCES**

- A. Aluminum Association Incorporated (AA):SAS-30 Specifications for Aluminum Structures.
- B. American Architectural Manufacturers Association (AAMA):
  - 1. 501.1: Standard Test Method for Metal Curtain Walls for Water Penetration Using Dynamic Pressure.
  - 2. 501.2: Field Check of Metal Curtain Walls for Water Leakage.
  - 3. 501.3: Field Check of Water Penetration Through Installed Exterior Windows, Curtain Walls and Doors by Uniform Air Pressure Difference.
  - 4. 603.8: Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum.
  - 5. 605.2: Specification for High Performance Organic Coatings on Architectural Extrusions and Panels.
  - 6. 606.1: Voluntary Guide Specification and Inspection Methods for Integral Color Anodic Finishes for Architectural Aluminum.
  - 7. 607.1: Voluntary Guide Specification and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum.
- C. American National Standards Institute (ANSI): Z 97.1 -2004- Safety Glazing Materials Used in Buildings -Safety Performance Specifications and Methods of Test.
- D. American Society for Testing and Materials (ASTM):
  - 1. A193: Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High Temperature Service.
  - 2. A307: Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
  - 3. B209: Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
  - 4. B211: Specification for Aluminum-Alloy Bar, Rod and Wire.
  - 5. B221: Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.

6. B316: Specification for Aluminum and Aluminum-Alloy Rivet and Cold-Heading Wire and Rods.
  7. C719: Standard Test Method for Adhesion and Cohesion of Elastomeric Joint Sealants Under Cycle Movement.
  8. C794: Test Method for Adhesion-In-Peel of Elastomeric Joint Sealants.
  9. C1036: Specification for Flat Glass.
  10. 1C1048: Specification for Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass.
  11. D395: Test Methods for Rubber Property -Compression Set.
  12. D412: Test Methods for Rubber Properties in Tension.
  13. D1171: Test Method for Rubber Deterioration -Surface Ozone Cracking Outdoors or Chamber (Triangular Specimens).
  14. D2240: Test Method for Rubber Property -Durometer Hardness.
  15. E283: Test Method for Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors.
  16. E330: Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.
  17. E331: Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.
  18. E773: Test Method for Seal Durability of Sealed Insulating Glass Units.
  19. E774: Specification for Sealed Insulating Glass Units.
  20. E783: Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.
- E. Consumer Product Safety Commission (CPSC): 16CFR 1201 - Architectural Glazing Standards and Related Material.
- F. Flat Glass Manufacturers Association (FGMA): Glazing Manual.
- G. Insulating Glass Certification Council (IGCC): Classification of Insulating Glass Units.

#### 1.4 SYSTEM DESCRIPTION

- A. Design Requirements:
1. Extruded aluminum members with a system of alternate serrations for attachment of exterior glass retainers with 1/4-in. x 20 stainless steel screws and snap-on beauty caps.
  2. Condensation guttering system integral with skylight framing members for positive drainage of condensation.
  3. Flush glazed exterior horizontal joints with field applied structural silicone.
  4. Full silicone wet seals along both sides of all exterior glass retainers.
- B. Performance Requirements:
1. Structural Members: Of sufficient sizes to support design loads as prescribed by governing building codes.
  2. The deflection of the framing member in a direction normal to the plane of glass when subjected to a uniform load deflection test in accordance with ASTM E330, and per the above specified loads, shall not exceed L/175, up to 1-in. maximum, for clear spans under 20-ft., or L/240 for clear spans greater than 20-ft.
  3. The deflection of a framing member in a direction parallel to the plane of glass, when carrying its full dead load, shall not exceed an amount which will reduce the glass or panel bite below 75% of the design dimension and the member shall have a 1/8-in. minimum clearance between itself and the edge of the fixed panel, glass, or component immediately adjacent, nor shall it impair the function of or damage any joint seals.
  4. Water Penetration: No water penetration shall occur when the system is tested in accordance with ASTM E331 using a differential static pressure of (20% of the inward acting design wind load pressure, but not less than (12 psf). Water penetration is defined as the appearance of uncontrolled water other than condensation on the interior surface of any part of the skylight.

- a. Drain water penetrating at joints, as well as condensation occurring within the system to exterior face of the work.
5. Thermal Movement: Provide for expansion and contraction of component materials as will be caused by an exterior surface temperature range of (+/-) 85 °F, ranging from -20 °F to 150 °F, and an interior surface temperature range of (+/-) 40 °F, ranging from 40 °F to 120 °F. Adjustments in the exterior and interior temperature ranges should be made, based on specific project locations and conditions. The skylight system should allow for thermal movements without buckling, sealant failure, undue material stress, and other detrimental affects.
6. Where permitted by code, a 1/3 increase in allowable stress for wind or seismic load shall be acceptable, but not in combination with any reduction applied to combined loads. In no case shall allowable values exceed the yield stress.
7. Compression flanges of flexural members may be assumed to receive effective lateral bracing only from anchors to the building structure and horizontal glazing bars or interior trim which are in contact with 50% of the member's total depth.
8. Skylight framing is designed to be self-supporting between the support construction. The skylight(s) will impose reactions to the support construction. All adjacent and support construction must support the transfer of all loads including horizontal and vertical, exerted by the skylight(s). Design or structural engineering services for the supporting structure or building components not included in the skylight scope are not included under this section.
9. Limited reaction design: The skylight framing is to be designed to exert no horizontal reactions under vertical gravity type loads, (dead, snow, live). Unbalanced live loads, (wind, seismic, etc.), acting upon the skylight will produce horizontal reactions that cannot be controlled by the skylights, but must be resisted by the support structure.

## **1.5 SUBMITTALS**

- A. Submit shop drawings showing plans, elevations and sections as required to fully describe the skylight construction for the Architect's approval prior to starting fabrication.
- B. Delegated Design: Submit structural calculations prepared in accordance with the Aluminum Association's Specifications for Aluminum Structures (SAS30) by a engineer qualified in the design of self-supporting sloped glazed systems licensed in state where skylight is to be installed.
- C. With regard to structural silicone joinery, submit:
  1. Certification that adhesion of sealant to samples of metal and glass is adequate when tested in accordance with ASTM C794.
  2. Certification that materials in contact with sealant are compatible with sealant after being exposed to 2,000-4,000 micro watt ultra-violet radiation for twenty-one (21) days.
  3. Statement that stress on each detailed sealant joint will not exceed design stress of sealant when exposed to specified wind loads.
- D. Submit manufacturer's samples of each type of sealant.
- E. Submit 6-in. long samples of extrusions with appropriate finish.
- F. Submit as-built drawings and cleaning and maintenance manuals upon completion of skylight installation.
- G. Certification that insulating glass units will withstand specified design loads.
- H. Qualifications of testing agency.

## 1.6 QUALITY ASSURANCE

- A. Work of this Section, including design, engineering, fabrication, finishing, preparation at the job site, erection and glazing of the skylight system shall be the responsibility of the skylight manufacturer. The manufacturer shall be regularly engaged in the preceding phases of construction of skylights and able to demonstrate that he has performed successfully on comparably sized projects and of comparable design complexity over at least the previous ten (10) years.

## 1.7 WARRANTY

- A. Submit manufacturer's warranty certifying that skylight work was furnished and installed in accordance with the Contract Documents.
- B. Certify that skylight frame is free of defects in design, material, and construction for a period of ten (10) years from the Date of Skylight Completion.
- C. Warrant structural sealant for a period of ten (10) years per sealant manufacturer's standard warranty of merchantable quality. Warranty shall certify that cured sealant:
  - 1. Will not become brittle or crack due to weathering or normal expansion and contraction of adjacent surfaces.
  - 2. Will not harden beyond a Shore A durometer of 50, nor soften below a minimum of 10 points.
  - 3. Will not change color significantly when used with compatible back-up materials.
  - 4. Will not bleed significantly.
- D. 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. Failures include, but are not limited to, checking, crazing, peeling, chalking, and fading of finishes.
  - 2. Warranty Period: 20 years from date of Substantial Completion.
- E. Optional extended warranties may be available on some products at an additional cost.
- F. Warranty service becomes effective only following payment in full for the contract amount.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Contract documents are based on products manufactured by Super Sky Products Enterprises, LLC, or approved equivalent.

### 2.2 MATERIALS

- A. Framework:
  - 1. Principal Supporting Members: .125-in. minimum thickness extruded aluminum, alloy 6005-T5 or 6061-T6 per ASTM B221. Sizes, shapes and profiles as indicated on the Contract Drawings.
  - 2. Snap-on Covers and Miscellaneous Non-supporting Trim: .062-in. minimum thickness extruded aluminum, alloy 6063-T5 per ASTM B221.
  - 3. Supporting aluminum gutters: thickness as prescribed by skylight engineer, based on skylight reactions and applied design loads.
  - 4. Principal Formed Metal Members: .125-in. minimum thickness aluminum, alloy 5052 or 6061-T6 per ASTM B209.
- B. Glazing Strips:

1. Extruded EDPM rubber designed to comply with the following specifications:
    - a. Hardness: ASTM D2240, Type A: Durometer 50 (+/-5).
    - b. Tensile Strength: ASTM D412. 800 psi (min.).
    - c. Elongation: 300% (min.).
    - d. Color: Black.
  2. Compression Set: ASTM D395 Method B, 22 hours @ 212 °F: 25% (max.).
  3. Heat Aging Characteristics:
    - a. 70 hours @ 212 °F.
    - b. Hardness: ASTM D2240, Type A: Durometer 50 (+/-5).
    - c. Tensile Change: ASTM D412. -10%.
    - d. Elongation Change: ASTM D412: -20%.
  4. ASTM D1171 Weather Resistance at 1 Part Ozone per Million, 500 hours at 20% Elongation: No cracks.
  5. No visual checks, cracks or breaks after completion of tests.
- C. Setting Blocks:
1. Extruded Type II silicone rubber designed to permit adhesion and comply with the following specifications:
    - a. Hardness: ASTM D2240, Type A: Durometer 80 (+/-5).
    - b. Color: Black.
- D. Fasteners:
1. For Exterior Cap Retainers: ASTM A193 B8 300 series stainless steel screws.
  2. For Framework Connections: ASTM B211 2024-T4 aluminum, ASTM A193 B8 300 series stainless steel, and ASTM B316 aluminum rivets, as required by connection.
  3. For Anchoring Skylight to Support Structure: ASTM A307 zinc plated steel fasteners.
  4. Exposed stainless steel truss head mechanical fasteners are utilized in accordance with standard connection details.
- E. Flashing:
1. Stainless Steel, 040-in. minimum thickness.
  2. Sheet metal flashings/closures/claddings are to be furnished shop formed to profile in min.
  3. 10-ft. lengths. When lengths exceed 10-ft., field trimming of the flashing and field forming the ends is necessary to suit as-built conditions. Sheet metal ends are to overlap 6-in. to 8-in. minimum, set in a full bed of sealant and riveted if required.
- F. Exposed metal finish interior and exterior to comply with the following:
1. High Performance Pigmented Organic Coatings: AAMA 2605-05 4-coat min. 50% PVDF fluropolymers, metallic, custom color to match Architect's sample.
- G. Glass:
1. See Division 08 Section "Glazing."
- H. Sealants:
1. Structural Flush Glazed Joints: High performance silicone sealant applied in accordance with manufacturer's recommendations.
  2. Non-structural Flush Glazed Joints and Weather Seal Joints: Silicone sealants applied in accordance with manufacturer's recommendations.
  3. Structural silicone sealant performance requirements:
    - a. Hardness: ASTM D2240 Type A, 30 durometer.
    - b. Ultimate Tensile Strength: ASTM D412, 170 psi.
    - c. Tensile at 150% Elongation: ASTM D412, 80 psi.
    - d. Joint Movement Capability after 14 Day Cure: ASTM C719, (+/-) 50%.
    - e. Peel Strength (aluminum, glass, concrete) after twenty-one (21) Day Cure: ASTM C794, 50 ppi.
  4. Structural silicone shall not be used to support dead weight of vertical glass or panels.

## **2.3 FABRICATION**

- A. Construct skylight using extruded aluminum members.
- B. Construct skylight using a continuous aluminum curb with expansion joints as required.
- C. Insofar as practicable, fit and assemble work in the manufacturer's shop. Work which cannot be permanently assembled shall be shop-assembled, marked, and disassembled before shipment to the jobsite.
- D. Design rafter bars for slide-in type spline glazing strips.
- E. Design glass retainer fasteners to resist uplift loadings. Spacing to be determined by structural calculations, when applicable.
- F. Use snap-on beauty caps to conceal glass retainers and glass retainer fasteners.
- G. Shop locate drill and bolt, or weld aluminum clips to framing members.
- H. Set glass with interior and exterior EDPM glazing strips.
- I. Use silicone setting blocks to support glass and to provide edge clearances and glass bites as outlined below, in accordance with FGMA recommendations:
  - 1. Set blocks not less than 6-in. from edge of glass for support unit.
  - 2. Glass Bite: Not less than 1/2-in. nor more than 5/8-in. on any side of glass unit.
  - 3. Maintain 1/4-in. edge clearance between glass and adjacent metal framework.
  - 4. Use rubber spacers to maintain separation of glass and adjacent metal framework.
- J. Locate weepholes in curb to positively drain condensation to exterior of skylight at each rafter connection.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Upon arrival to the jobsite for installation of the specified work, the manufacturer's erector is to examine the structure and substrate to determine that they are properly prepared, dimensionally accurate, and ready to receive the skylight work included herein. Report any discrepancies to the General Contractor. Correction of faulty work to be at the expense of the responsible party/s. The skylight manufacturer is not responsible for faulty structure or substrate.

### **3.2 PREPARATION**

- A. Contact between aluminum and dissimilar metals shall receive a protective coating of asphaltic paint for the prevention of electrolytic action and corrosion.
- B. Skylight manufacturer and manufacturer's erector excludes all field measuring, demolition, removal, replacement, or re-work of any existing material.

### **3.3 INSTALLATION**

- A. Install skylight frame, glass and accessory items as needed in accordance with manufacturer's instructions.
- B. Install skylight system under the direction of the skylight manufacturer's designated erector.

- C. Erect system plumb and true, in proper alignment and relation to established lines and grades as shown on approved shop drawings.
- D. Anchor skylight to structure in strict accordance with approved shop drawings.
- E. Use high performance silicone sealants to seal horizontal joints between glass panels and silicone sealant to wet seal joints between snap-on cap retainers and glass.
- F. Apply sealing materials in strict accordance with sealant manufacturer's instructions. Before application, remove mortar dirt, dust, moisture and other foreign matter from surfaces it will contact. Mask adjoining surfaces to maintain a clean and neat appearance. Tool sealing compounds to fill the joint and provide a smooth finish.
- G. Furnishing of temporary covering and weather-proofing of the skylight openings, if required by the General Contractor, and removal of the protective measures during and after the skylight installation is excluded by the manufacturer and the manufacturer's erector. ANY TEMPORARY COVERINGS THAT MAY BE REQUIRED ARE NOT TO OBSTRUCT OR INTERFERE WITH THE SKYLIGHT INSTALLATION IN ANYWAY.

### **3.4 TOLERANCES**

- A. All parts of the work, when completed, shall be within the following tolerances:
  1. Maximum variation from plane or location shown on approved shop drawings: 1/8-in. per 12-ft. length, or 1/2-in. in total length.
  2. Maximum offset from true alignment between two members abutting end-to-end, edge-to-edge in line or separated by less than 3-in.: 1/32-in.

### **3.5 FIELD QUALITY CONTROL**

- A. Owner will engage a qualified testing agency for water leakage tests.
- B. Water Leakage: Field check in accordance with AAMA 501.2 in proportionate areas. There shall be no uncontrolled water leakage as defined in AAMA 501.2. Water supply to the skylights, with adequate water pressure, is to be furnished by the General Contractor. Tests are to be conducted upon completion of the installation with no remobilization or down time included to accommodate either water supply availability or witness personnel schedules. Testing is to be performed by the manufacturer's authorized personnel with a maximum of five (5) man-hours for set-up, testing and clean-up. Independent laboratory testing and reports, if required, are to be ordered and directed by the Owner and/or General Contractor.

### **3.6 CLEANING**

- A. Install skylight frame and associated metal to avoid soiling or smudging the finish.
- B. Clean glass and frame at time of installation. Final cleaning, if required, subsequent to completion of project, is not to be performed by the manufacturer.

### **3.7 PROTECTION**

- A. The skylight manufacturer does not provide, nor does it include any temporary protection of the skylight and its materials after the installation is complete. Protection of the skylight from ongoing work by other trades shall be the responsibility of the General Contractor. The manufacturer is responsible only for the damage caused by the personnel under its control and responsibility.

### **3.8 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
  - 1. Separate tempered glass waste for use as aggregate of nonstructural fill.
- C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- D. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 08 44 33**



## **08 71 00 – DOOR HARDWARE**

### **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 commercial door hardware for the following:
  - 1. Swinging doors.
- B. Door hardware includes, but is not necessarily limited to, the following:
  - 1. Mechanical door hardware.
  - 2. Electromechanical door hardware.
  - 3. Automatic operators.
- C. Related Sections:
  - 1. Division 06 Section "Rough Carpentry".
  - 2. Division 08 Section "Door Schedule".
  - 3. Division 08 Section "Door Hardware Sets".
  - 4. Division 08 Section "Hollow Metal Doors and Frames".
  - 5. Division 08 Section "Interior Aluminum Doors and Frames".
  - 6. Division 08 Section "Flush Wood Doors".
  - 7. Division 28 Section "Access Control".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
  - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
  - 2. ICC/IBC - International Building Code.
  - 3. NFPA 70 - National Electrical Code.
  - 4. NFPA 80 - Fire Doors and Windows.
  - 5. NFPA 101 - Life Safety Code.
  - 6. NFPA 105 - Installation of Smoke Door Assemblies.
  - 7. UL/ULC and CSA C22.2 – Standards for Automatic Door Operators Used on Fire and Smoke Barrier Doors and Systems of Doors.
  - 8. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards:
  - 1. ANSI/BHMA Certified Product Standards - A156 Series
  - 2. UL10C – Positive Pressure Fire Tests of Door Assemblies

#### **1.3 SUBMITTALS**

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
  - 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
  3. Content: Include the following information:
    - a. Type, style, function, size, label, hand, and finish of each door hardware item.
    - b. Manufacturer of each item.
    - c. Fastenings and other pertinent information.
    - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    - e. Explanation of abbreviations, symbols, and codes contained in schedule.
    - f. Mounting locations for door hardware.
    - g. Door and frame sizes and materials.
    - h. Warranty information for each product.
  4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:
1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:
    - a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
    - b. Complete (risers, point-to-point) access control system block wiring diagrams.
    - c. Wiring instructions for each electronic component scheduled herein.
  2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- E. Informational Submittals:
1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals.

#### 1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

- B. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.
- D. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
  - 1. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- E. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.
- F. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
  - 1. Function of building, purpose of each area and degree of security required.
  - 2. Plans for existing and future key system expansion.
  - 3. Requirements for key control storage and software.
  - 4. Installation of permanent keys, cylinder cores and software.
  - 5. Address and requirements for delivery of keys.
- G. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
  - 1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
  - 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
  - 3. Review sequence of operation narratives for each unique access controlled opening.
  - 4. Review and finalize construction schedule and verify availability of materials.
  - 5. Review the required inspecting, testing, commissioning, and demonstration procedures
- H. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

## **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.

- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

## **1.6 COORDINATION**

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door Hardware and Electrical Connections: Coordinate the layout and installation of scheduled electrified door hardware and related access control equipment with required connections to source power junction boxes, low voltage power supplies, detection and monitoring hardware, and fire and detection alarm systems.
- C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

## **1.7 WARRANTY**

- A. General Warranty: Reference Division 01, General Requirements. Special warranties 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. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
  - 1. Structural failures including excessive deflection, cracking, or breakage.
  - 2. Faulty operation of the hardware.
  - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 4. Electrical component defects and failures within the systems operation.
- C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:
  - 1. Ten years for mortise locks and latches.
  - 2. Five years for exit hardware.
  - 3. Twenty five years for manual surface door closer bodies.
  - 4. Five years for motorized electric latch retraction exit devices.
  - 5. Two years for electromechanical door hardware.

## **1.8 MAINTENANCE SERVICE**

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

## **PART 2 - PRODUCTS**

### **2.1 SCHEDULED DOOR HARDWARE**

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.

- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.

## 2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
1. Quantity: Provide the following hinge quantity, regardless of otherwise indicated:
    - a. Two Hinges: For doors with heights up to 60 inches.
    - b. Three Hinges: For doors with heights 61 to 90 inches.
    - c. Four Hinges: For doors with heights 91 to 120 inches.
    - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
  2. Hinge Size: Provide the following, with hinge widths sized for door thickness and clearances required:
    - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
    - b. Sizes from 3'1" to 4'0": 5" heavy weight as specified or not.
  3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
    - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
    - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
  4. Hinge Options: Comply with the following:
    - a. Non-removable 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 the all out-swinging lockable doors.
  5. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
    - a. Bommer Industries (BO).
    - b. Hager Companies (HA).
    - c. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
- B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.
1. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
    - a. Bommer Industries (BO).
    - b. Hager Companies (HA).
    - c. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
    - d. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).

## 2.3 POWER TRANSFER DEVICES

- A. Electrified Quick Connect Transfer Hinges: Provide electrified transfer hinges with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.
1. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
    - a. Hager Companies (HA) - ETW-QC (# wires) Option.

- b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - QC (# wires) Option.
- B. Concealed Quick Connect Electric Power Transfers: Provide concealed wiring pathway housing mortised into the door and frame for low voltage electrified door hardware. Furnish with Molex™ standardized plug connectors and sufficient number of concealed wires (up to 12) to accommodate the electrified functions specified in the Door Hardware Sets. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Wire nut connections are not acceptable.
  - 1. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
    - a. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE) – EL-CEPT Series.
    - b. Securitron (SU) - EL-CEPT Series.
- C. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.
  - 1. Provide one each of the following tools as part of the base bid contract, or approved equivalent.
    - a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Electrical Connecting Kit: QC-R001.
    - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Connector Hand Tool: QC-R003.
  - 2. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
    - a. Hager Companies (HA) - Quick Connect.
    - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) – QC-C Series.

## 2.4 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.
  - 1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
  - 2. Furnish dust proof strikes for bottom bolts.
  - 3. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
  - 4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
  - 5. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
    - a. Burns Manufacturing (BU).
    - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
    - c. Trimco (TC).
- B. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.
  - 1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
  - 2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.

3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
5. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
  - a. Hiawatha, Inc. (HI).
  - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
  - c. Trimco (TC).

## 2.5 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
- B. Cylinders: Original manufacturer cylinders complying with the following:
  1. Mortise Type: Threaded cylinders with rings and cams to suit hardware application.
  2. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
  3. Bored-Lock Type: Cylinders with tailpieces to suit locks.
  4. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
  5. Keyway: Match Facility Restricted Keyway.
- C. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
  1. Interchangeable Cores: Core insert, removable by use of a special key; usable with other manufacturers' cylinders.
- D. Patented Cylinders: ANSI/BHMA A156.5, Grade 1, certified patented cylinders employing a utility patented and restricted keyway requiring the use of a patented key. Cylinders are to be protected from unauthorized manufacture and distribution by manufacturer's United States patents. Cylinders are to be factory keyed with owner having the ability for on-site original key cutting.
  1. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
    - a. KABA SFIC Cores Coordinate # of pins prior to ordering hardware.
    - b. No Substitution.
- E. Keying System: Each type of lock and cylinders to be factory keyed.
  1. Conduct specified "Keying Conference" to define and document keying system instructions and requirements.
  2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
  3. Existing System: Key locks to Owner's existing system.
- F. Key Quantity: Provide the following minimum number of keys:
  1. Change Keys per Cylinder: Three (3).
  2. Master Keys (per Master Key Level/Group): Five (5).
  3. Construction Control Keys (where required): Two (2).
  4. Permanent Control Keys (where required): Two (2).
- G. Construction Keying: Provide Keyed temporary keyed construction cores at Exterior Doors only. Disposable plastic cores for all interior locksets.
- H. Key Registration List (Bitting List):

1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
  2. Provide transcript list in writing or electronic file as directed by the Owner.
- I. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.
1. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
    - a. Lund Equipment (LU).
    - b. MMF Industries (MM).
    - c. Telkee (TK).
- J. Key Control Software: Provide one network version of "Key Wizard" branded key management software package that includes one year of technical support and upgrades to software at no charge. Provide factory key system formatted for importing into "Key Wizard" software.

## **2.6 MECHANICAL LOCKS AND LATCHING DEVICES**

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 certified. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.
1. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
    - a. Corbin Russwin Hardware (RU) – ML2000 Series.
    - b. Schlage (SC) – L9000 Series.

## **2.7 LOCK AND LATCH STRIKES**

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
  2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
  3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
  4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.
- B. Standards: Comply with the following:
1. Strikes for Mortise Locks and Latches: BHMA A156.13.
  2. Strikes for Bored Locks and Latches: BHMA A156.2.
  3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
  4. Dustproof Strikes: BHMA A156.16.

## **2.8 ELECTRIC STRIKES**

- A. Standard Electric Strikes: Heavy duty, cylindrical and mortise lock electric strikes conforming to ANSI/BHMA A156.31, Grade 1, UL listed for both Burglary Resistance and for use on fire rated door assemblies. Stainless steel construction with dual interlocking plunger design tested to exceed 3000 lbs. of static strength and 350 ft-lbs. of dynamic strength. Strikes tested for a minimum 1 million operating cycles. Provide strikes with 12 or 24 VDC capability and supplied standard as fail-secure unless otherwise specified. Provide latchbolt and latchbolt strike monitoring indicating both the position of the latchbolt and locked condition of the strike where specified.



1. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
  - a. HES (HS).

## 2.9 CONVENTIONAL EXIT DEVICES

- A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:
1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
  2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
  3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
  4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
  5. Flush End Caps: Provide flush end caps made of architectural metal in the same finish as the devices as in the Hardware Sets. Plastic end caps will not be acceptable.
  6. Electromechanical Options: Subject to same compliance standards and requirements as mechanical exit devices, electrified devices to be of type and design as specified in hardware sets. Include any specific controllers when conventional power supplies are not sufficient to provide the proper inrush current.
  7. Motorized Electric Latch Retraction: Devices with an electric latch retraction feature must use motors which have a maximum current draw of 600mA. Solenoid driven latch retraction is not acceptable.
  8. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
    - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
    - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
  9. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
  10. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
  11. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
  12. Rail Sizing: Provide exit device rails factory sized for proper door width application.
  13. Through Bolt Installation: For exit devices and trim at all Fire Exit / Panic devices.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 certified panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.
1. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
    - a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
    - b. Von Duprin (VD) - 35A/98 XP Series.

## 2.10 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers including installation and adjusting information on inside of cover.
  2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
  3. Cycle Testing: Provide closers which have surpassed 15 million cycles in a test witnessed and verified by UL.
  4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the physically handicapped, provide units complying with ANSI ICC/A117.1.
  5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
  6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
  7. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
  8. All closers shall be mounted w/ Sex Nuts and Bolts.
- B. Door Closers, Surface Mounted (Heavy Duty): ANSI/BHMA A156.4, Grade 1 surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron or aluminum alloy body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units standard.
1. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
    - a. Corbin Russwin Hardware (RU) – DC6000 Series.
    - b. Norton Door Controls (NO) - 7500 Series.
    - c. LCN (LN) 4000 / 4100 Series.

## **2.11 SURFACE MOUNTED CLOSER HOLDERS**

- A. Single Point Closer Holders: Single point closer holder designed to hold open fire or smoke rated doors until interruption of signal from fire alarm, smoke detector or remote release switch. Pull side, push side, or double egress mounting applications available with non-handed track and closer body and dual voltage input (24V/120V). Voltage to be 24VDC unless otherwise specified. Pull side mounted closers to have minimum adjustable hold-open range of 85 to 110 degrees. Auxiliary door stops are required at hold open point.
1. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
    - a. Norton Door Controls (NO) - 7200 Series.
    - b. Corbin Russwin (RU) DC62900 Series.

## **2.12 ARCHITECTURAL TRIM**

- A. Door Protective Trim
1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
  2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.

3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
  - a. Stainless Steel: 300 grade, 050-inch thick.
5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
  - a. Hiawatha, Inc. (HI).
  - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
  - c. Trimco (TC).

## **2.13 DOOR STOPS AND HOLDERS**

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
  1. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
    - a. Hiawatha, Inc. (HI).
    - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
    - c. Trimco (TC).
- C. Overhead Door Stops and Holders: ANSI/BHMA A156.6, Grade 1 certified overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.
  1. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
    - a. Dorma (DO).
    - b. Rixson Door Controls (RF).

## **2.14 ARCHITECTURAL SEALS**

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. 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 perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: 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 UL-10C.
  1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.

- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- 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. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
  1. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
  2. Reese Enterprises, Inc. (RE).

## **2.15 ELECTRONIC ACCESSORIES**

- A. Door Position Switches: Door position magnetic reed contact switches specifically designed for use in commercial door applications. On recessed models the contact and magnetic housing snap-lock into a 1" diameter hole. Surface mounted models include wide gap distance design complete with armored flex cabling. Provide SPDT, N/O switches with optional Rare Earth Magnet installation on steel doors with flush top channels.
  1. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
    - a. Security Door Controls (SD) - DPS Series.
    - b. Securitron (SU) - DPS Series.
- B. Switching Power Supplies: Provide UL listed or recognized filtered and regulated power supplies. Provide single, dual, or multi-voltage units as shown in the hardware sets. Units must be expandable up to eight Class 2 power limited outputs. Units must include the capability to incorporate a battery backup option with integral battery charging capability in addition to operating the DC load in event of line voltage failure. Provide the least number of units, at the appropriate amperage level, sufficient to exceed the required total draw for the specified electrified hardware and access control equipment.
  1. Manufacturers: Basis of Design: Provide manufacturers listed below, or approved equivalent.
    - a. Securitron (SU) - AQ Series.

## **2.16 FABRICATION**

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

## **2.17 FINISHES**

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

### **3.2 PREPARATION**

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

### **3.3 INSTALLATION**

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
  - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically 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. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
  - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
  - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and 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 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

### **3.4 FIELD QUALITY CONTROL**

- A. Field Inspection: Supplier will perform a final inspection of installed door hardware and state in report whether work complies with or deviates from requirements, including whether door hardware is properly installed, operating and adjusted.

### **3.5 ADJUSTING**

- A. Initial 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.

### **3.6 CLEANING AND PROTECTION**

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

### **3.7 DEMONSTRATION**

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

### **3.8 DOOR HARDWARE SETS**

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
- B. Refer to Division 08 Section "Door Hardware Sets", for hardware sets.

### **3.9 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Steel.
  - 3. Plastic Materials
  - 4. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.

**END OF SECTION 08 71 00**

## **SECTION 08 71 10 – DOOR HARDWARE SETS**

### **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 references specification sections relating to commercial door hardware for the following:
  - 1. Swinging doors.
  - 2. Sliding Doors.
  - 3. Other doors to the extent indicated.
- B. Commercial door hardware includes, but is not necessarily limited to, the following:
  - 1. Mechanical door hardware.
  - 2. Electromechanical and access control door hardware.
  - 3. Electromechanical and access control door hardware power supplies, back-ups and surge protection.
  - 4. Automatic operators.
  - 5. Cylinders specified for doors in other sections.
- C. Related Sections:
  - 1. Division 08 Section "Hollow Metal Doors and Frames".
  - 2. Division 08 Sections "Flush and Clad Wood Doors".
  - 3. Division 08 Section "Door Hardware".
  - 4. Division 26 Sections "Electrical".
  - 5. Division 28 Section "Access Control".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
  - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
  - 2. ICC/IBC - International Building Code.
  - 3. NFPA 70 - National Electrical Code.
  - 4. NFPA 80 - Fire Doors and Windows.
  - 5. NFPA 101 - Life Safety Code.
  - 6. NFPA 105 - Installation of Smoke Door Assemblies.
  - 7. State Building Codes, Local Amendments.
- E. Standards: Reference Related Sections for requirements regarding compliance with applicable industry standards.

#### **1.3 SUBMITTALS**

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
  - 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."

2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
  3. Content: Include the following information:
    - a. Type, style, function, size, label, hand, and finish of each door hardware item.
    - b. Manufacturer of each item.
    - c. Fastenings and other pertinent information.
    - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    - e. Explanation of abbreviations, symbols, and codes contained in schedule.
    - f. Mounting locations for door hardware.
    - g. Door and frame sizes and materials.
  4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Keying Schedule: Prepared under the supervision of the Owner, separate schedule detailing final keying instructions for locksets and cylinders in writing. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner to approve submitted keying schedule prior to the ordering of permanent cylinders.
- D. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and contact information of the manufacturers providing the hardware and their nearest service representatives. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.
- F. Warranties and Maintenance: Special warranties and maintenance agreements specified in the Related Sections.

#### **1.4 QUALITY ASSURANCE**

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum [5] years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Installer Qualifications: Installers, trained by the primary product manufacturers, with a minimum [3] years documented experience installing both standard and electrified builders hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- C. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum [5] years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor in good standing by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.



- D. Source Limitations: Obtain each type and variety of Door Hardware specified in the Related Sections from a single source, qualified supplier unless otherwise indicated.
- E. Regulatory Requirements: Comply with NFPA 70, NFPA 80, NFPA 101 and ANSI A117.1 requirements and guidelines as directed in the applicable model building code.
- F. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.

## **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

## **1.6 COORDINATION**

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door and Frame Preparation: Division 08 Sections (Steel, Aluminum and Wood) doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

## **1.7 WARRANTY**

- A. General Warranty: Reference Division 01, General Requirements. Special warranties 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.

## **1.8 MAINTENANCE SERVICE**

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

## **PART 2 - PRODUCTS**

### **2.1 SCHEDULED DOOR HARDWARE**

- A. Refer to "PART 3 – EXECUTION" for required specification sections.

## **PART 3 - EXECUTION**

### **3.1 DOOR HARDWARE SETS**

- A. The door hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
- B. The supplier is responsible for handing and sizing all products and providing the correct option for the appropriate door type and material where more than one is presented in the hardware sets. Quantities listed are for each pair of doors, or for each single door.
- C. Products listed in the Door Hardware Sets must meet the requirements described in the specification sections noted.
  - 1. Section 08 71 00 – Door Hardware.
  - 2. Section 08 71 13 – Automatic Door Operators.
  - 3. Section 28 13 00 – Access Control.
- D. Manufacturer's Abbreviations:
  - 1. MK - McKinney
  - 2. PE - Pemko
  - 3. RF - Rixson
  - 4. RO - Rockwood
  - 5. RU - Corbin Russwin
  - 6. AD - Adams Rite
  - 7. SU - Securitron
  - 8. HS - HES
  - 9. NO - Norton
  - 10. DE - Detex Corporation
  - 11. SA - Sargent
  - 12. OT - OTHER
- E. Symbols:
  - 1. ⚡ - Electrical Component

### 3.2 HARDWARE SETS

**SET: 00**

Doors: 228, 229, 230, 231, 232, 331, 332, 333, 334, 335, 429, 430, 431, 432, 433  
 Description: GLASS DOOR

1	All Hardware by Glass Door Manuf	Hardware supplied w/ Glass Door		OT	081411	
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**SET: 1.0**

Doors: 300A2  
 Description: MAIN ENTRY

2	Continuous Hinge	CFMxxSLI-HD1 EL-CEPTx32D Cut to ____"		PE	087100	
1	Exit Device (concealed vertical rod, storeroom)	ED4800 O855 M110 M92 MELR M54 M51 CT7SD	630	RU	087100	↘
1	Exit Device (concealed vertical rod, exit only)	ED4800 EO M110 M92 MELR M54 M51	630	RU	087100	↘
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
2	Door Pull	RM3300-84 Mtg-Type 6HD MP	US32D	RO	087100	
1	Surface Closer	CPS7500 SNB134-47 2018D	689	NO	087100	
1	Automatic Opener	Auto Operator Campus Standard	689		087113	↘
1	Threshold	273x4AFG FHSL14SS-2		PE	087100	
2	ElectroLynx Door Harness	QC-Cxxx		MK	087100	↘
2	ElectroLynx Frame Harness	QC-C3000P		MK	087100	↘
1	Door Management Alarm	ES4200		DE		↘
2	Position Switch	DPS-_- based on frame material / finish color		SU	087100	↘
1	Door Switch	503		NO	087100	↘
1	Door Switch	504		NO	087100	↘
1	Power Supply	AQD6-8C1R		SU	087100	↘

Notes: PERIMETER GASKETING SHALL BE PROVIDED BY ALUMINUM DOOR/ FRAME MANUFACTURER.

CARD / FOB READERS PROVIDED BY OTHERS.

INSTALL CVR DEVICE AS FAR TO LOCK EDGE AS POSSIBLE TO ALLOW FOR 48" PULL TO BE FREE OF KEY/THUMBTURN.

**SET: 1.5**

Doors: 300A1

Description: MAIN ENTRY

2	Continuous Hinge	CFMxxSLI-HD1 EL-CEPTx32D Cut to ____"		PE	087100	
1	Exit Device (concealed vertical rod, storeroom)	ED4800 O855 M110 M92 MELR M54 M51 CT7SD	630	RU	087100	↙
1	Exit Device (concealed vertical rod, exit only)	ED4800 EO M110 M92 MELR M54 M51	630	RU	087100	↙
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
2	Door Pull	RM3300-84 Mtg-Type 6HD MP	US32D	RO	087100	
2	Surface Closer	CPS7500 SNB134-47 2018D	689	NO	087100	
1	Threshold	273x4AFG FHSL14SS-2		PE	087100	
2	ElectroLynx Door Harness	QC-Cxxx		MK	087100	↙
2	ElectroLynx Frame Harness	QC-C3000P		MK	087100	↙
2	Position Switch	DPS-_- based on frame material / finish color		SU	087100	↙
1	Power Supply	AQD6-8C1R		SU	087100	↙

Notes: PERIMETER GASKETING SHALL BE PROVIDED BY ALUMINUM DOOR/ FRAME MANUFACTURER.

CARD / FOB READERS PROVIDED BY OTHERS.

INSTALL CVR DEVICE AS FAR TO LOCK EDGE AS POSSIBLE TO ALLOW FOR 48" PULL TO BE FREE OF KEY/THUMBTURN.

TIE ES4200 FROM 300A2 INTO THIS DOOR AS WELL.

**SET: 2.0**

Doors: 300A

Description: VESTIBULE

2	Continuous Hinge	CFMxxxSLI-HD1 Cut to ____ "		PE	087100	
1	Magnetic Lock	DM62BD		SU	087100	↙
2	Door Pull	RM3300-84 Mtg-Type 6HD MP	US32D	RO	087100	
2	Conc Overhead Stop	1-X36	630	RF	087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Automatic Opener	Auto Operator Campus Standard	689		087113	↙
1	Threshold	276A MSES25SS		PE	087100	
1	Door Management Alarm	ES4200		DE		↙
1	Door Switch	503		NO	087100	↙
2	Electromechanical Bar	EMB-CL		SU	087100	↙
1	Push Button	EEB2		SU	087100	↙
1	Power Supply	AQD6-8C1R		SU	087100	↙

Notes: PERIMETER GASKETING SHALL BE PROVIDED BY ALUMINUM DOOR/ FRAME MANUFACTURER.

CARD / FOB READER BY OTHERS

**SET: 3.0**

Doors: A-2A, B-2A

Description: EGRESS STAIR

2	Continuous Hinge	CFMxxxSLI-HD1 Cut to ____ "		PE	087100	
1	Exit Device (concealed vertical rod, exit only)	ED4800 EO M110 M54 M51	630	RU	087100	
1	Exit Device (concealed vertical rod, classroom)	ED4800 O1455 M110 M54 M51 CT7SD	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
2	Surface Closer	CPS7500 SNB134-47 2018D	689	NO	087100	
1	Threshold	273x4AFG FHSL14SS-2		PE	087100	
2	Sweep	345CV TKSP8		PE	087100	
1	Door Management Alarm	ES4200		DE		↙
2	Position Switch	DPS-_- based on frame material / finish color		SU	087100	↙

Notes: PERIMETER GASKETING SHALL BE PROVIDED BY ALUMINUM DOOR/ FRAME MANUFACTURER.

**SET: 4.0**

Doors: 300F

Description: REAR DELIVERY REMOTE RELEASE

5	Hinge (heavy weight)	T4A3386	US32D	MK	087100	
1	Hinge (heavy weight)	T4A3386 QCxxx	US32D	MK	087100	
2	Flush Bolt	555	US26D	RO	087100	
1	Dust Proof Strike	570	US26D	RO	087100	
1	Storeroom Lock	ML2057 RSA SA1xx CT7SD	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Electric Strike	1006CLB-LBM	630	HS	087100	↘
1	ElectroLynx Adaptor	2004M		HS	087100	↘
1	Buzzer	2006M		HS	087100	↘
1	SMART Pac Bridge Rectifier	2005M3		HS	087100	↘
2	Surface Closer	CPS7500T SNB134-47	689	NO	087100	
1	Threshold	253X6AFG FHSL14SS-2		PE	087100	
2	Bracket	BKT050SP TKSP8		PE		
1	Gasketing	315CR TKSP8		PE	087100	
2	Sweep	345CV TKSP8		PE	087100	
1	Astragal	357SP 84" TKSP8		PE	087100	
1	ElectroLynx Door Harness	QC-Cxxx		MK	087100	↘
1	ElectroLynx Frame Harness	QC-C3000P		MK	087100	↘
2	Position Switch	DPS-_- based on frame material / finish color		SU	087100	↘

**SET: 5.0**

Doors: 300E

Description: REAR DELIVERY VEST

6	Hinge	TA2714	US26D	MK	087100	
2	Push Pull	BF 111x73C/73CL Mtg-Type 1HD	US32D	RO	087100	
2	Surface Closer	CPS7500T SNB134-47	689	NO	087100	
2	Door Stop	441CU / 401	US26D	RO	087100	
1	Threshold	1716A MSES25SS-2		PE	087100	
1	Gasketing	S88		PE	087100	

**SET: 6.0**

Doors: 401B, 401C

Description: BALCONY

1	Continuous Hinge	CFMxxxSLI-HD1 Cut to ____ "		PE	087100	
1	Deadlatch	4900 31/32" BS 1	628	AD	087100	
1	Lever Operator	4600 (deadlatches) MI	US32D	AD	087100	
1	Exit Device Trim	3080 MI 3	US32D	AD	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Cylinder Housing	1040-138- CAM- CT7SD	630	RU	087100	
1	Surface Closer	CPS7500 SNB134-47 2018D	689	NO	087100	
1	Conc Overhead Stop	1-X36	630	RF	087100	
1	Threshold	273x4AFG FHSL14SS-2		PE	087100	
1	Position Switch	DPS-_- based on frame material / finish color		SU	087100	↙

Notes: PERIMETER GASKETING SHALL BE PROVIDED BY ALUMINUM DOOR/ FRAME MANUFACTURER.

**SET: 10.0**

Doors: 100C, 200D, 400C

Description: CARD ACCESS

3	Hinge	TA2714	US26D	MK	087100	
1	Hinge	TA2714 QCxxx	US26D	MK	087100	
1	Electrified Mortise Lock	ML20906-SEC 110X SA1xx M92 CT7SD	630	RU	087100	↙
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Kick Plate	K1050 10" BEV CSK	US32D	RO	087100	
1	Door Stop	441CU / 401	US26D	RO	087100	
1	ElectroLynx Door Harness	QC-Cxxx		MK	087100	↙
1	ElectroLynx Frame Harness	QC-C3000P		MK	087100	↙
1	Position Switch	DPS-_- based on frame material / finish color		SU	087100	↙
1	Power Supply	EPS-05		SU	087100	↙

Notes: CARD / FOB READERS PROVIDED BY OTHERS.

**SET: 10.1**

Doors: 302A

Description: CARD ACCESS

3	Hinge	TA2714	US26D	MK	087100	
1	Hinge	TA2714 QCxxx	US26D	MK	087100	
1	Electrified Mortise Lock	ML20906-SEC 110X SA1xx M92 CT7SD	630	RU	087100	↙
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Kick Plate	K1050 10" BEV CSK	US32D	RO	087100	
1	Mop Plate	K1050 10" BEV CSK	US32D	RO	087100	
1	Door Stop	441CU / 401	US26D	RO	087100	
1	ElectroLynx Door Harness	QC-Cxxx		MK	087100	↙
1	ElectroLynx Frame Harness	QC-C3000P		MK	087100	↙
1	Position Switch	DPS-_- based on frame material / finish color		SU	087100	↙
1	Power Supply	EPS-05		SU	087100	↙

Notes: CARD / FOB READERS PROVIDED BY OTHERS.

**SET: 10.2**

Doors: 201, 202, 204, 300G

Description: CARD ACCESS

3	Hinge	TA2714	US26D	MK	087100	
1	Hinge	TA2714 QCxxx	US26D	MK	087100	
1	Electrified Mortise Lock	ML20906-SEC 110X SA1xx M92 CT7SD	630	RU	087100	↙
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Door Stop	441CU / 401	US26D	RO	087100	
1	ElectroLynx Door Harness	QC-Cxxx		MK	087100	↙
1	ElectroLynx Frame Harness	QC-C3000P		MK	087100	↙
1	Position Switch	DPS-_- based on frame material / finish color		SU	087100	↙
1	Power Supply	EPS-05		SU	087100	↙

Notes: CARD / FOB READERS PROVIDED BY OTHERS.

PERIMETER GASKETING SHALL BE PROVIDED BY ALUMINUM DOOR/ FRAME MANUFACTURER.



**SET: 10.3**

Doors: 217B, 417

Description: CARD ACCESS

3	Hinge	TA2714	US26D	MK	087100	
1	Hinge	TA2714 QCxxx	US26D	MK	087100	
1	Electrified Mortise Lock	ML20906-SEC 110X SA1xx M92 CT7SD	630	RU	087100	↙
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Conc Overhead Stop	1-X36	630	RF	087100	
1	ElectroLynx Door Harness	QC-Cxxx		MK	087100	↙
1	ElectroLynx Frame Harness	QC-C3000P		MK	087100	↙
1	Position Switch	DPS-_- based on frame material / finish color		SU	087100	↙
1	Power Supply	EPS-05		SU	087100	↙

Notes: CARD / FOB READERS PROVIDED BY OTHERS.

PERIMETER GASKETING SHALL BE PROVIDED BY ALUMINUM DOOR/ FRAME MANUFACTURER.

**SET: 10.4**

Doors: 407B

Description: CARD ACCESS

3	Hinge	TA2714	US26D	MK	087100	
1	Hinge	TA2714 QCxxx	US26D	MK	087100	
1	Electrified Mortise Lock	ML20906-SEC 110X SA1xx M92 CT7SD	630	RU	087100	↙
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Conc Overhead Stop	1-X36	630	RF	087100	
1	ElectroLynx Door Harness	QC-Cxxx		MK	087100	↙
1	ElectroLynx Frame Harness	QC-C3000P		MK	087100	↙
1	Position Switch	DPS-_- based on frame material / finish color		SU	087100	↙
1	Power Supply	EPS-05		SU	087100	↙

Notes: CARD / FOB READERS PROVIDED BY OTHERS.

PERIMETER GASKETING SHALL BE PROVIDED BY ALUMINUM DOOR/ FRAME MANUFACTURER.

**SET: 10.5**

Doors: 317A, 318

Description: CARD ACCESS PAIR

7	Hinge	TA2714	US26D	MK	087100	
1	Hinge	TA2714 QCxxx	US26D	MK	087100	
2	Flush Bolt	555	US26D	RO	087100	
1	Dust Proof Strike	570	US26D	RO	087100	
1	Electrified Mortise Lock	ML20906-SEC 110X SA1xx M92 CT7SD	630	RU	087100	↙
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Conc Overhead Stop	1-X36	630	RF	087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Conc Overhead Stop	1-X36	630	RF	087100	
1	ElectroLynx Door Harness	QC-Cxxx		MK	087100	↙
1	ElectroLynx Frame Harness	QC-C3000P		MK	087100	↙
2	Position Switch	DPS-__ based on frame material / finish color		SU	087100	↙
1	Power Supply	EPS-05		SU	087100	↙

Notes: CARD / FOB READERS PROVIDED BY OTHERS.

PERIMETER GASKETING SHALL BE PROVIDED BY ALUMINUM DOOR/ FRAME MANUFACTURER.

**SET: 11.0**

Doors: 113, 114, 115, 116, 117, 120, 124, 125, 128, 129, 130, 201A, 201B, 204A, 216, 218, 219, 220, 319, 320, 321, 322, 323, 324, 404, 405, 406A, 406B, 418A, 421, 423, 424, 425

Description: OFFICE / GROUP STUDY

4	Hinge	TA2714	US26D	MK	087100	
1	Dormitory Lock	ML2065 110X SA1xx M19SN CT7SD	630	RU	087100	
2	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Door Stop	441CU / 401	US26D	RO	087100	

**SET: 11.5**

Doors: 306, 307A

Description: BOH OFFICE

4	Hinge	TA2714	US26D	MK	087100	
1	Dormitory Lock	ML2065 RSA M34 SA1xx CT7SD	630	RU	087100	
2	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Door Stop	441CU / 401	US26D	RO	087100	

**SET: 12.0**

Doors: 119

Description: MECHANICAL CLOSET

4	Hinge	TA2714	US26D	MK	087100	
1	Storeroom Lock	ML2057 110X SA1xx CT7SD	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Conc Overhead Stop	1-X36	630	RF	087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Kick Plate	K1050 10" BEV CSK	US32D	RO	087100	
1	Gasketing	S88		PE	087100	

**SET: 12.5**

Doors: 107, 108, 109, 109A, 110, 211, 212, 213, 214, 309, 310, 414, 415, 416, 416A

Description: MECHANICAL CLOSET BOH

4	Hinge	TA2714	US26D	MK	087100	
1	Storeroom Lock	ML2057 RSA SA1xx M21 CT7SD	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Kick Plate	K1050 10" BEV CSK	US32D	RO	087100	
1	Door Stop	441CU / 401	US26D	RO	087100	
1	Gasketing	S88		PE	087100	

**SET: 12.6**

Doors: 307B

Description: TECH SERVICES CLOSET

4	Hinge	TA2714	US26D	MK	087100	
1	Storeroom Lock	ML2057 RSA SA1xx M21 CT7SD	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Gasketing	S88		PE	087100	

**SET: 13.0**

Doors: 126B, 203

Description: STORAGE CLOSET

4	Hinge	TA2714	US26D	MK	087100	
1	Storeroom Lock	ML2057 110X SA1xx CT7SD	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Kick Plate	K1050 10" BEV CSK	US32D	RO	087100	
1	Door Stop	441CU / 401	US26D	RO	087100	

**SET: 13.5**

Doors: 126A

Description: STORAGE CLOSET OHSTOP

4	Hinge	TA2714	US26D	MK	087100	
1	Storeroom Lock	ML2057 110X SA1xx CT7SD	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Surface Closer	CPS7500 SNB134-47	689	NO	087100	
1	Kick Plate	K1050 10" BEV CSK	US32D	RO	087100	

**SET: 14.0**

Doors: 214A, 214B

Description: ELECTRICAL CLOSET

4	Hinge	TA2714	US26D	MK	087100	
1	Exit Device (rim, nightlatch)	ED5200A R957 M110 CT7SD	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Kick Plate	K1050 10" BEV CSK	US32D	RO	087100	
1	Door Stop	441CU / 401	US26D	RO	087100	
1	Gasketing	S88		PE	087100	

**SET: 15.0**

Doors: 214C

Description: MECHANICAL AREAWAY

4	Hinge (heavy weight)	T4A3386	US32D	MK	087100	
1	Storeroom Lock	ML2057 RSA SA1xx M21 CT7SD	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Surface Closer	CPS7500 SNB134-47	689	NO	087100	
1	Threshold	1719+, 13"wide, mill finish		PE	087100	
1	Gasketing	315CR TKSP8		PE	087100	
1	Rain Guard	346C TKSP8		PE	087100	
1	Sweep	345CV TKSP8		PE	087100	

**SET: 15.5**

Doors: 214E

Description: MECHANICAL AREAWAY PAIR

8	Hinge (heavy weight)	T4A3386	US32D	MK	087100	
2	Flush Bolt	555	US26D	RO	087100	
1	Dust Proof Strike	570	US26D	RO	087100	
1	Storeroom Lock	ML2057 RSA SA1xx M21 CT7SD	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Conc Overhead Stop	1-X36	630	RF	087100	
1	Surface Closer	CPS7500 SNB134-47	689	NO	087100	
1	Threshold	1719+, 13"wide, mill finish		PE	087100	
1	Gasketing	315CR TKSP8		PE	087100	
1	Rain Guard	346C TKSP8		PE	087100	
2	Sweep	345CV TKSP8		PE	087100	
1	Astragal	357SP 84" TKSP8		PE	087100	

**SET: 16.0**

Doors: 222

Description: STORAGE PAIR

6	Hinge	TA2714	US26D	MK	087100	
2	Flush Bolt	555	US26D	RO	087100	
1	Dust Proof Strike	570	US26D	RO	087100	
1	Storeroom Lock	ML2057 110X SA1xx CT7SD	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
2	Surf Overhead Stop	9-X36	630	RF	087100	

**SET: 16.5**

Doors: 300C

Description: MECHANICAL PAIR

8	Hinge	TA2714	US26D	MK	087100	
2	Flush Bolt	555	US26D	RO	087100	
1	Dust Proof Strike	570	US26D	RO	087100	
1	Storeroom Lock	ML2057 110X SA1xx CT7SD	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
2	Surface Closer	Pull side closer			087100	
2	Wall Stop	401	US26D	RO	087100	

Notes: CARD / FOB READERS PROVIDED BY OTHERS.

**SET: 16.6**

Doors: 307

Description: MECHANICAL PAIR

8	Hinge	TA2714	US26D	MK	087100	
2	Flush Bolt	555	US26D	RO	087100	
1	Dust Proof Strike	570	US26D	RO	087100	
1	Storeroom Lock	ML2057 RSA SA1xx CT7SD	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
2	Surface Closer	CPS7500T SNB134-47	689	NO	087100	
2	Wall Stop	401	US26D	RO	087100	

Notes: CARD / FOB READERS PROVIDED BY OTHERS.

**SET: 17.0**

Doors: 103, 104, 105, 106, 207, 208, 209, 210, 304, 305, 313, 314, 315, 316, 410, 411, 412, 413

Description: SINGLE USE RESTROOM

4	Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK	087100	
1	Privacy Set	ML2030 110X M34 SA1xx M19V	630	RU	087100	
1	Kick Plate	K1050 10" BEV CSK	US32D	RO	087100	
1	Mop Plate	K1050 10" BEV CSK	US32D	RO	087100	
1	Gasketing	S88		PE	087100	
1	Coat Hook	RM823	US32D	RO	087100	

**SET: 18.0**

Doors: 205, 311, 408

Description: PASSAGE

4	Hinge	TA2714	US26D	MK	087100	
1	Passage Latch	ML2010 110X SA1xx	630	RU	087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Door Stop	441CU / 401	US26D	RO	087100	

**SET: 18.5**

Doors: 308

Description: BOH PASSAGE

4	Hinge	TA2714	US26D	MK	087100	
1	Passage Latch	ML2010 RSA SA1xx	630	RU	087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Kick Plate	K1050 10" BEV CSK	US32D	RO	087100	
1	Door Stop	441CU / 401	US26D	RO	087100	

**SET: 19.0**

Doors: 102, 206, 312, 409

Description: JANITOR'S CLOSET

4	Hinge	TA2714	US26D	MK	087100	
1	Storeroom Lock	ML2057 110X SA1xx CT7SD	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Kick Plate	K1050 10" BEV CSK	US32D	RO	087100	
1	Door Stop	441CU / 401	US26D	RO	087100	

**SET: 20.0**

Doors: B-1, B-2, B-3, B-4

Description: STAIR SINGLE

4	Hinge	TA2714	US26D	MK	087100	
1	Exit Device (rim, classroom)	ED5200A 110955 M110 M54	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Gasketing	S88		PE	087100	
1	Position Switch	DPS-__ based on frame material / finish color		SU	087100	↙
1	Door Stop	441CU / 401	US26D	RO	087100	

**SET: 20.1**

Doors: A-1, A-2, A-3, A-4

Description: STAIR SINGLE

1	Door Stop	441CU / 401	US26D	RO	087100	
	All Other Hardware Supplied by Fire Rated Door Supplier				084123	

**SET: 20.5**

Doors: 401A

Description: STAIR EGRESS ONLY

4	Hinge	TA2714	US26D	MK	087100	
1	Exit Device (rim, classroom)	ED5200A 110955 M110 M54	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Surface Closer	CPS7500 SNB134-47	689	NO	087100	
1	Gasketing	S88		PE	087100	
1	Position Switch	DPS-_- based on frame material / finish color		SU	087100	↙

**SET: 22.0**

Doors: 317B

Description: CLASSROOMS OH STOP

4	Hinge (heavy weight)	T4A3786 4-1/2" x 4-1/2"	US26D	MK	087100	
1	Classroom Intruder Lock	ML2052 110X SA1xx M19N CT7SD	630	RU	087100	
2	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Conc Overhead Stop	1-X36	630	RF	087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Gasketing	S88		PE	087100	

**SET: 23.0**

Doors: 101B, 215B, 420B

Description: CLASSROOM PANIC

4	Hinge	TA2714	US26D	MK	087100	
1	Exit Device (rim, classroom)	ED5202 110955 M110 M54 M51 CT7SD	630	RU	087100	
2	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Conc Overhead Stop	1-X36	630	RF	087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	

Notes: SEE DOOR SCHEDULE FOR THRESHOLD TYPES AND DETAILS.



**SET: 23.5**

Doors: 101A

Description: CLASSROOM PANIC CARD ACCESS

3	Hinge	TA2714	US26D	MK	087100	
1	Hinge	TA2714 QCxxx	US26D	MK	087100	
1	Electric Exit Device (rim, fail secure)	ED5200 1109905 M110 M51 CT7SD	630	RU	087100	↙
2	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Conc Overhead Stop	1-X36	630	RF	087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	ElectroLynx Door Harness	QC-Cxxx		MK	087100	↙
1	ElectroLynx Frame Harness	QC-C3000P		MK	087100	↙
1	Power Supply	AQD6-8C1R		SU	087100	↙

Notes: CARD / FOB READERS PROVIDED BY OTHERS.

**SET: 24.0**

Doors: 422

Description: CONFERENCE

4	Hinge	TA2714	US26D	MK	087100	
1	Passage Latch	ML2010 110X SA1xx	630	RU	087100	
1	Conc Overhead Door Stop	1-X36	630	RF	087100	

**SET: 25.0**

Doors: 303

Description: CIRC DESK

4	Hinge	TA2714	US26D	MK	087100	
1	Passage Latch	ML2010 110X M30	630	RU	087100	
1	Conc Overhead Stop	1-X36	630	RF	087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	

Notes: PERIMETER GASKETING SHALL BE PROVIDED BY ALUMINUM DOOR/ FRAME MANUFACTURER.

**SET: 26.0**

Doors: 303A, 406

Description: OFFICE SUITE ENTRY

4	Hinge	TA2714	US26D	MK	087100	
1	Dormitory Lock	ML2065 110X SA1xx M19SN CT7SD	630	RU	087100	
2	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Door Stop	441CU / 401	US26D	RO	087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	

**SET: 26.1**

Doors: 407A, 418

Description: OFFICE SUITE ENTRY

4	Hinge	TA2714	US26D	MK	087100	
1	Dormitory Lock	ML2065 110X SA1xx M19SN CT7SD	630	RU	087100	
2	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Conc Overhead Stop	1-X36	630	RF	087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	

**SET: 26.5**

Doors: 217A

Description: OFFICE SUITE ENTRY

4	Hinge	TA2714	US26D	MK	087100	
1	Dormitory Lock	ML2065 110X SA1xx M19SN CT7SD	630	RU	087100	
2	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Door Stop	441CU / 401	US26D	RO	087100	
1	Position Switch	DPS-_- based on frame material / finish color		SU	087100	↙

**SET: 27.0**

Doors: 400D

Description: HOLD OPEN

4	Hinge	TA2714	US26D	MK	087100	
1	Dormitory Lock	ML2065 110X SA1xx M19SN CT7SD	630	RU	087100	
2	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Door Stop & Holder	491R	US26D	RO	087100	

**SET: 28.0**

Doors: 100E

Description: KRAME CTR

4	Hinge	TA2714	US26D	MK	087100	
1	Exit Device (rim, classroom)	ED5202 110955 M110 M54 M51 CT7SD	630	RU	087100	
1	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Door Stop	441CU / 401	US26D	RO	087100	

Notes: PERIMETER GASKETING SHALL BE PROVIDED BY ALUMINUM DOOR/ FRAME  
MANUFACTURER.

**SET: 28.5**

Doors: 100F

Description: KRAME CTR VEST

4	Hinge	TA2714	US26D	MK	087100	
2	Door Pull	RM3300-12 Mtg-Type 6HD / 8HD as req'd	US32D	RO	087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Door Stop	441CU / 401	US26D	RO	087100	

Notes: PERIMETER GASKETING SHALL BE PROVIDED BY ALUMINUM DOOR/ FRAME  
MANUFACTURER.

SEE DOOR SCHEDULE FOR THRESHOLD TYPES AND DETAILS.

BtoB mounted RM3300's

**SET: 29.0**

Doors: 215A, 420A

Description: PANIC PAIR

6	Hinge	TA2714	US26D	MK	087100	
2	Exit Device (concealed vertical rod, classroom)	Concealed Vertical Rod	630	RU	087100	
2	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Conc Overhead Stop	1-X36	630	RF	087100	
2	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	
1	Conc Overhead Stop	1-X36	630	RF	087100	

Notes: SEE DOOR SCHEDULE FOR THRESHOLD TYPES AND DETAILS – ROOM 215A ONLY.

**SET: 30.0**

Doors: 126, 127

Description: EGRESS

4	Hinge	TA2714	US26D	MK	087100	
1	Exit Device (rim, classroom)	ED5202 110955 M110 M54 M51 CT7SD	630	RU	087100	
2	Core	6 or 7-PIN SFIC Core keyed to campus master	630		087100	
1	Conc Overhead Stop	1-X36	630	RF	087100	
1	Surface Closer	PR7500 / R7500 SNB134-47 // TBGN134-47	689	NO	087100	

Notes: SEE DOOR SCHEDULE FOR THRESHOLD TYPES AND DETAILS.

**3.3 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Steel.
  - 3. Plastic Materials
  - 4. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.

**END OF SECTION 08 71 10**

## **SECTION 08 71 13 – AUTOMATIC DOOR OPERATORS**

### **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. Power door operators.
  - 2. Push plate switches.
- B. Related Sections include the following:
  - 1. Division 8 Sections "Door Hardware" and "Door Hardware Sets" for door hardware that must be coordinated with automatic door operator.
  - 2. Division 26 and 27 Sections for electrical connections including conduit and wiring for automatic door operators.

#### **1.3 DEFINITIONS**

- A. Activation Device: Device that, when actuated, sends electrical signal to automatic door operator to open door.
- B. Safety Device: Device that prevents door from opening or closing.

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Design automatic entrances, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Automatic entrances shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- D. Operating Temperature Range: Provide automatic entrances that operate within minus 20 to plus 122 deg F.
- E. Air Infiltration: Maximum air leakage through fixed glazing and framing areas of 1.25 cfm/sq. ft. of fixed entrance system area when tested according to ASTM E 283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft.
- F. Opening-Force Requirements:
  - 1. Power-Operated Doors: Not more than 50 lbf required to manually set door in motion if power fails, and not more than 15 lbf required to open door to minimum required width.
  - 2. Power-Operated Swinging Doors: Not more than 30 lbf required to manually open door if power fails.
  - 3. Accessible Interior Doors: Not more than 5 lbf to fully open door.

- G. Entrapment Force Requirements:
- H.
  - 1. Power-Operated Swinging Doors: Not more than 40 lbf required to prevent stopped door from closing or completely opening.

## **1.5 SUBMITTALS**

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for automatic entrances. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For automatic entrances. Include plans, elevations, sections, details, hardware mounting heights, 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.
  - 2. Wiring Diagrams: For power, signal, and control wiring.
  - 3. Activation and safety devices.
  - 4. Include hardware schedule and indicate hardware types, functions, quantities, and locations.
- C. Samples for Initial Selection: For units with factory-applied color and metal-cladding finishes.
- D. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- E. Delegated-Design Submittal: For automatic entrances indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- F. Qualification Data: For Installer.
- G. Product Certificates: For each type of emergency-exit automatic entrance, from manufacturer.
- H. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for automatic entrances.
- I. Field quality-control reports.
- J. Maintenance Data: For automatic entrances, safety devices, and control systems to include in maintenance manuals.
- K. Warranties: Sample of special warranties.

## **1.6 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 two hours' normal travel time from Installer's place of business to Project site.
- B. Manufacturer Qualifications: Company certificate issued by AAADM.
- C. Testing Agency Qualifications: An independent agency with inspector certified by AAADM.

- D. Source Limitations: Obtain automatic door operators 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. UL Standard: Comply with UL 325.
- G. Preinstallation Conference: Conduct conference at Project site.

## **1.7 PROJECT CONDITIONS**

- A. Field Measurements: Verify door openings by field measurements before fabrication of exposed covers for automatic door operators and indicate measurements on Shop Drawings.

## **1.8 COORDINATION**

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing automatic door operators. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing automatic door operators to comply with indicated requirements.
- B. Electrical System Roughing-in: Coordinate layout and installation of automatic door operators with connections to power supplies and security access control system.

## **1.9 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of automatic door operators that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Faulty or sporadic operation of automatic door operator or activation and safety devices.
    - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering or use.
  - 2. Warranty Period: Two years from date of Substantial Completion.

## **1.10 MAINTENANCE SERVICE**

- A. Maintenance: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of automatic door operator Installer. Include quarterly planned and preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
  - 1. Engage inspector certified by AAADM to perform safety inspection after each adjustment or repair and at end of maintenance period. Submit completed inspection form to Owner.
  - 2. Perform maintenance, including emergency callback service, during normal working hours.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
  - 1. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
  - 2. Sheet and Plate: ASTM B 209.

## **2.2 DOOR OPERATORS AND ACTIVATION AND SAFETY DEVICES**

- A. Door Operators: Provide door operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for long-term, maintenance-free operation under normal traffic load for type of occupancy indicated.
  - 1. Basis-of-Design: Provide GT8500 Heavy Duty / Low Energy ADA door operators as manufactured by Nabco, or approved equivalent.
  - 2. Door Operator Performance: Provide door operators that will open and close doors and maintain them in fully closed position when subjected to Project's design wind loads.
  - 3. Electromechanical Operators: Concealed, self-contained, overhead unit powered by fractional-horsepower, permanent-magnet dc motor; with closing speed controlled mechanically by gear train and dynamically by braking action of electric motor; with solid-state microprocessor controller; UL 325; and with manual operation with power off.
  
- B. Push-Plate Switch: Provide door control stations on each side of each automatically operated door in locations shown on Drawings.
  - 1. Basis-of-Design Product: Provide square push switch by Wikk Industries, Inc. or approved equivalent.
    - a. 4" x 4" square.
    - b. Type 304 Stainless Steel cover plate in Brushed Satin finish.
  
- C. Electrical Interlocks: Unless units are equipped with self-protecting devices or circuits, provide electrical interlocks to prevent activation of operator when door is locked, latched, or bolted.

## **2.3 HARDWARE**

- A. General: Provide units in sizes and types recommended by automatic entrance and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish unless otherwise indicated.
  
- B. Manual Opening for Power-Operated Swinging Doors: Provide hardware that in a power failure allows door to open with a manual force not to exceed 30 lbf according to BHMA A156.10.
  
- C. Hinges, Push Bars, Pull Handles, Exit Devices, Thresholds and Weather Stripping: Reference Division 8 Sections "Door Hardware" and "Door Hardware Sets."

## **2.4 FABRICATION**

- A. General: Factory fabricate automatic entrance components to designs, sizes, and thicknesses indicated and to comply with indicated standards.
  - 1. Form aluminum shapes before finishing.
  - 2. 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.
  - 3. Use concealed fasteners to greatest extent possible. Where exposed fasteners are required, use countersunk Phillips flat-head machine screws, finished to match framing.
    - a. Where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration, use self-locking devices.
    - b. Reinforce members as required to receive fastener threads.
  - 4. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
  
- B. Framing: Provide automatic entrances as prefabricated assemblies. Complete fabrication, assembly, finishing, hardware application, and other work before shipment to Project site.
  - 1. Fabricate tubular and channel frame assemblies with manufacturer's standard welded or mechanical joints. Provide subframes and reinforcement as required for a complete system to support required loads.



2. Perform fabrication operations in manner that prevents damage to exposed finish surfaces.
  3. Form profiles that are sharp, straight, and free of defects or deformations.
  4. Provide components with concealed fasteners and anchor and connection devices.
  5. Fabricate components with accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion.
  6. Fabricate exterior components to drain water passing joints and condensation and moisture occurring or migrating within system to the exterior.
  7. Provide anchorage and alignment brackets for concealed support of assembly from building structure.
  8. Allow for thermal expansion of exterior units.
- C. Door Operators: Factory fabricated and installed in headers, including adjusting and testing.
- D. Hardware: Factory install hardware to greatest extent possible; remove only as required for final finishing operation and for delivery to and installation at Project site. Cut, drill, and tap for factory-installed hardware before applying finishes.
1. Provide sliding-type weather stripping, mortised into door, at perimeter of doors.
  2. Provide compression-type weather stripping at fixed stops of exterior doors. At locations without fixed stops, provide sliding-type weather stripping retained in adjustable strip mortised into door edge.
  3. Provide weather sweeps mounted to underside of door bottoms of exterior doors.
- E. Activation and Safety Devices:
1. General: Factory install devices in doors and headers as required by BHMA A156.10 for type of door and direction of travel.

## **2.5 GENERAL FINISH REQUIREMENTS**

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Apply organic and anodic finishes to formed metal after fabrication unless otherwise indicated.
- D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## **2.6 ALUMINUM FINISHES**

- A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker to match Aluminum Curtain Wall Framing.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances, door and frame supports, and other conditions affecting performance of automatic door operators.
  1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance.
- B. Examine roughing-in for electrical systems to verify actual locations of power connections before automatic door operator installation.

- C. Examine roughing-in for compressed-air piping systems to verify actual locations of piping connections before automatic door operator installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. General: Install complete automatic door operator system, including activation and safety devices, control wiring, and remote power units.
- B. Power Door Operator Installation Standard: Comply with BHMA A156.10 for installation.
- C. Low-Energy Power Door Operator Installation Standard: Comply with BHMA A156.19 for installation.
- D. Automatic Door Operators: Install door operator system, including control wiring, as follows:
  - 1. Refer to Division 26 and 27 Sections for connection to electrical power distribution system.
  - 2. Refer to Division 22 and 23 Sections for connection to compressed-air distribution piping.
- E. Activation and Safety Devices: Install devices and wiring, including connections to automatic door operators, according to BHMA A156.10 and as follows:
  - 1. Wall Switches: Provide push plates on both sides of each opening indicated to receive automatic door operators.
- F. Connect wiring according to Division 26 Electrical sections.

### **3.3 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Testing and Inspecting: After installation has been completed, testing and inspecting of each automatic door operator shall be performed to verify compliance with applicable BHMA standards.
  - 1. Inspection Report: Submit report in writing to Architect and Contractor within 24 hours after inspection.
- C. Remove and replace automatic door operators where test results indicate they do not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, shall be performed to determine compliance of replaced or additional work with specified requirements.

### **3.4 ADJUSTING**

- A. Adjust automatic door operators and activation and safety devices to operate smoothly, easily, and properly, and for safe operation and weathertight closure.
  - 1. Adjust doors with low-energy door operators to close according to BHMA A156.19.
- B. Lubricate operators, hardware, and other moving parts.
- C. After completing installation of exposed, factory-finished automatic door operators, inspect exposed finishes and repair damaged finishes.
- D. Readjust automatic door operators and activation and safety devices after repeated operation of completed installation equivalent to three days' use by normal traffic (100 to 300 cycles). Lubricate hardware, operating equipment, and other moving parts.

- E. Occupancy Adjustment: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site outside normal occupancy hours for this purpose, without additional cost.

### **3.5 DEMONSTRATION**

- A. Engage manufacturer's inspector certified by AAADM to train Owner's maintenance personnel to adjust, operate, and maintain automatic door operators.

### **3.6 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
  - 1. Separate tempered glass waste for use as aggregate of nonstructural fill.
- C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Stainless steel.
  - 3. Plastic Materials
  - 4. Corrugated cardboard packaging.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 08 71 13**

## SECTION 08 80 00 - GLAZING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. 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. Glass for glazed curtain walls and sloped glazing
  2. Doors
  3. Glazed curtain walls.
  4. Glazed entrances.
  5. Sloped glazing.
  6. Interior glazed walls.
  7. Glazing sealants and accessories.
  8. Railings.
  9. Exterior fins attached to curtain walls.
  10. Fire-protection-rated glazing
- B. Related Requirements: Products specified in this section will be installed in conjunction with materials in the following sections:
  1. Division 05 Section "Decorative Metal."
  2. Division 05 Section "Decorative Metal Stairs & Railings."
  3. Division 05 Section "Glazed Interior Lightwell."
  4. Division 06 Section "Interior Architectural Woodwork."
  5. Division 08 Section "Hollow Metal Doors."
  6. Division 08 Section "Interior Aluminum Frames & Doors."
  7. Division 08 Section "Flush Wood Doors."
  8. Division 08 Section "Stile & Rail Wood Doors."
  9. Division 08 Section "Fire Rated Storefront & Doors."
  10. Division 08 Section "All-Glass Entrances & Storefront."
  11. Division 08 Section "Aluminum Entrance Doors."
  12. Division 08 Section "Glazed Aluminum Curtain Walls" for glazing sealants used in structural-sealant-glazed curtain walls.
  13. Division 08 Section "Sloped Glazing Assemblies."

#### 1.3 REFERENCES

- A. Abbreviations and Acronyms:
  1. AAMA American Architectural Manufacturers Association
  2. ANSI American National Standards Institute
  3. ASTM Formerly the American Society for Testing and Materials
  4. CPSC Consumer Products Safety Commission
  5. FT Fully Tempered
  6. GANA Glass Association of North America
  7. HS Heat-strengthened
  8. ICC International Code Council
  9. IGCC Insulating Glass Certification Council
  10. IGMA Insulating Glass Manufacturers Alliance
  11. LBNL Lawrence Berkeley National Laboratories
  12. Low-E Low emissivity
  13. LSG Light to Solar Gain

14.	NFRC	National Fenestration Rating Council
15.	SHGC	Solar Heat Gain Coefficient
16.	SC	Shading Coefficient
17.	VLT	Visible Light Transmittance

B. Definitions:

1. Deterioration of Coated Glass: Defects developing 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.
2. Deterioration of Insulating Glass: Failure of the 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.
3. 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, delaminating material obstructing vision through glass and blemishes exceeding those allowed by referenced laminated glass standards.
4. Interspace or Airspace: The space between lites of any insulating glass unit that contains dehydrated air or a specified gas.
5. Manufacturer: A firm that produces primary glass or fabricated glass products as defined in referenced glazing publications.

C. Reference Standards: This section does not require compliance with standards but is merely a listing of those used. If compliance is required, statements will be included in the appropriate Section.

1. ASTM C 1036 Standard Specification for Flat Glass
2. ASTM C 1048 Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass
3. ASTM C 1172 Standard Specification for Laminated Architectural Flat Glass
4. ASTM C 1376 Standard Specification for Pyrolytic and Vacuum Deposition Coatings on Flat Glass
5. ASTM E 2190 Standard Specification for Insulating Glass Unit Performance and Evaluation (*replaces ASTM E773, E774 CBA, CAN / CGSB 12.8*)
6. ASTM E 546 Standard Test Method for Frost/Dew Point of Sealed Insulating Glass Units
7. ASTM E 576 Standard Test Method for Frost/Dew Point of Sealed Insulating Glass Units in the Vertical Position
8. ASTM E 1300 Standard Practice for Determining Load Resistance of Glass in Buildings
9. ASTM C 1349 Standard Specification for Architectural Flat Glass Clad Polycarbonate
10. ASTM F 3057 Standard Test Method For Electromagnetic Shielding Effectiveness Of Glazings
11. ANSI Z97.1 Performance Specifications and Methods of Test for Safety Glazing Materials Used in Buildings
12. BS EN 14179 Glass in building - Heat-soaked thermally-toughened soda lime silicate safety glass
13. CPSC 16 CFR 1201 Safety Standard for Architectural Glazing Materials

#### 1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

#### 1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
2. Review temporary protection requirements for glazing during and after installation.

## **1.6 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Samples: Submit 12-inch (305 mm) long samples of each type of glass indicated except for clear monolithic glass products and make-ups with Viracon Thermal Spacer (VTS™), and 12-inch (305 mm) long samples of each color required, except black, for each type of sealant or gasket exposed to view.
- C. Glazing Accessory Samples: For sealants and spacers, in 12-inch lengths.
- D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
- E. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

## **1.7 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer and manufacturers of insulating-glass units with sputter-coated, low-E coatings glass testing agency.
- B. Product Certificates: For glass and glazing products.
- C. Product Test Reports: For coated glass, insulating glass and glazing sealants, for tests performed by a qualified testing agency.
  1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
- D. Preconstruction adhesion and compatibility test report.
- E. Sample Warranties: For special warranties.

## **1.8 QUALITY ASSURANCE**

- A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.
- B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C1021 to conduct the testing indicated.
- E. Mock-ups: Before glazing, build mockups for each glass product indicated in section 2.5 Product Schedule to verify selections and to demonstrate aesthetic effects and qualities of materials and execution.
  1. Construction: Build mockups with glass and glazing systems specified for the project, including typical lite size, framing systems and glazing methods.

2. Scheduling: Notify architect seven days in advance of dates and times when mockups will be available for viewing.
3. Quality Assurance: Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work. Accepted mockups may become part of the completed work if undisturbed at the time of substantial completion.

## **1.9 PRECONSTRUCTION TESTING**

- A. Preconstruction Adhesion and Compatibility Testing: Test each glass product, tape sealant, gasket, glazing accessory, and glass-framing member for adhesion to and compatibility with elastomeric glazing sealants.
1. Testing is not required if data are submitted based on previous testing of current sealant products and glazing materials matching those submitted.
  2. Use ASTM C1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets, and glazing channel substrates.
  3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
  4. Schedule enough time for testing and analyzing results to prevent delaying the Work.
  5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

## **1.10 DELIVERY, STORAGE, AND HANDLING**

- A. Storage and Handling Requirements:
1. Protect glass from edge damage during handling. For insulating units exposed to substantial altitude changes, comply with insulating glass manufacturers written recommendations for venting and sealing to avoid hermetic seal ruptures.
  2. Storage and Protection: Protect glazing materials according to manufacturer's written instructions and as needed to prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun or other causes.

## **1.11 FIELD CONDITIONS**

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F.

## **1.12 WARRANTY**

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty for Laminated Glass: Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to 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. Warranty Period: 10 years from date of Substantial Completion.
- C. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating

glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to 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.

1. Warranty Period: 10 years from date of Substantial Completion.

- D. Provide a written 12-year warranty from date of manufacture for insulating glass with a Viracon Thermal Spacer (VTS™). Warranty covers deterioration due to normal conditions of use and not to handling, installing, protecting and maintaining practices contrary to the glass manufacturer's published instructions

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Basis-of-Design Product: Provide glazing from [Viracon, Inc.](#), or an approved equivalent.
- B. Source Limitations for Glass and Glazing Accessories: Obtain from single source from single manufacturer for each glass type, product and installation method.

### **2.2 PERFORMANCE REQUIREMENTS**

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Division 1 "Quality Requirements," to design glazing.
- C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E1300.
1. Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.
    - a. Wind Design Data: As indicated on Structural Drawings.
  2. Design Snow Loads: As indicated on Structural Drawings.
  3. Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.
  4. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch, whichever is less.
  5. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
- D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites 6 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. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
  5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.



6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

## **2.3 GLASS PRODUCTS, GENERAL**

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
  1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
  2. AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."
  3. IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."
  4. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
  1. Minimum Glass Thickness for Exterior Lites: 6 mm.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

## **2.4 GLASS PRODUCTS**

- A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
- B. Ultraclear Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with visible light transmission of not less than 91 percent.
- C. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
  1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- D. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
  1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- E. Ceramic-Coated Vision Glass: ASTM C1048, Condition C, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3; and complying with Specification No. 95-1-31 in GANA's "Engineering Standards Manual."
  1. Glass: Clear float.
  2. Ceramic Coating Color: As selected by Architect from manufacturer's full range of standard and optional colors.

3. Ceramic Coating Pattern: As selected by Architect from manufacturer's full range of standard and optional patterns.
- F. Ceramic-Coated Spandrel Glass: ASTM C1048, Type I, Condition B, Quality-Q3.
1. Glass: Clear float.
  2. Ceramic Coating Color: As selected by Architect from manufacturer's full range of standard and optional colors.
  3. Ceramic Coating Pattern: As selected by Architect from manufacturer's full range of standard and optional patterns.

## 2.5 LAMINATED GLASS

- A. General Requirements
1. Laminated Glass: Comply with ASTM C 1172 for kinds of laminated glass indicated and other requirements specified.
  2. Interlayer: Interlayer material as indicated, clear or in colors, and 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.
  3. Laminating Process: Fabricate laminated glass to produce glass free of foreign substances and air or glass pockets as follows:
    - a. Laminate lites with polyvinyl butyral interlayer in autoclave with heat plus pressure.
    - b. Laminate lites with laminated glass manufacturer's standard cast-in-place and cured transparent resin interlayer.
  4. Fabrication Tolerances:
    - a. No delamination or air bubbles shall be permitted.
    - b. Edge Shift Tolerance:
      - 1) Tempered – Visible edges
        - a) Edge length greater than 0mm: +/- 1.0mm max
    - c. Overall thickness tolerance: +/- 0.5mm max.
    - d. Interlayer edge finish: All interlayer joints to have a smooth clean bright finish recessed from finished edge.
    - e. Where edges of laminated glass are indicated in the specifications or the drawings as exposed to the exterior, provide PVB interlayer suitable for exposure to exterior.
  5. Interlayer Color: Clear unless otherwise indicated.
- B. Material:
1. General: All Glass shall be Clear Soda-Lime Float Glass. Glass for glazing shall comply with the provisions of ASTM C1036 Standard Specification for Flat Glass and ASTM C1048 Standard Specification for Heat-Treated Flat Glass, Condition A (uncoated surfaces), Type I (transparent) tested for surface and edge compression per ASTM C 1048 and for impact strength per 16 CFR 1201 for Category II materials. Unless otherwise stated, glazing materials and installation shall comply with the provisions and recommendations of the Glass and Glazing Federation "Glazing Manual" or with the American FGMA Glazing Manual.
  2. Quality Control: All glass shall be manufactured and processed in a factory where the quality control procedures comply with ISO 9002 and are independently maintained.
  3. Defects: The glass shall be cut clean, without edge faults such as feathered edges, shells or other imperfections. In all structural applications such as glass fins or point-supported glass and with all toughened glass, all edges shall be ground to eliminate edge defects.
  4. Manufacturing Tolerances - In general as set out by ASTM C1036 -
    - a. Minimum Actual Glass Thickness for Nominal Specified Glass Thickness:
    - b. Not less than those specified in ASTM E 1300 Table A4.1
  5. Fabrication Tolerances:
    - a. Thickness <6mm (1/4")      8 & 10mm (5/16" & 3/8")      12 (1/2" & 15mm (5/8"))
    - b. Warp: ±0.196" per yard measured along straight edge
    - c. Any dim. < 3'-3"    ±0.04"    ±0.08"    ± 0.08"
    - d. Any dim. > 3'-3"    ±0.04"    ±0.08"    ±0.11"
    - e. Squareness shall be measured by a comparison of diagonals.
    - f. Diagonals up to 78.74": ±0.15".

- g. Diagonals over 78.74":  $\pm 0.19$ ".
  - h. Edge straightness:  $\pm 0.036$ " per foot
  - 6. All glass shall be prefabricated and delivered in the required sizes. No on-site cutting, nipping or drilling will be allowed.
  - 7. Edge working: All edges shall be ground and polished unless specifically indicated otherwise on construction documents.
  - 8. Provide fully tempered units where indicated and as required by Code.
- C. Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Laminated-Glass Types" Article.
  - D. General Performance: Laminated glazing assemblies attached to decorative metal framing shall withstand the effects of the following performance requirements without exceeding performance criteria or failure due to defective manufacture, fabrication, installation, or other defects in construction.
  - E. Structural Performance: Laminated glazing assemblies attached to decorative metal framing shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to SEI/ASCE 7.
    - 1. Seismic Loads: As indicated on Drawings.
    - 2. Deflection Limits: Deflection normal to glazing plane is limited to 1/175 of clear span or 3/4 inch, whichever is smaller.
  - F. Delegated Design: Design laminated glazing assemblies for attachment to decorative metal framing, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
  - G. Laminated Glass Fabrication
    - 1. Provide holes and cutouts in glass to receive hardware, fittings, and accessory fittings before tempering glass. Do not cut, drill, or make other alterations to glass after tempering.
      - a. Fully temper glass using horizontal (roller-hearth) process, and fabricate so that when glass is installed, roll-wave distortion is parallel with bottom edge of door or lite.
    - 2. Factory assemble components and factory install hardware and fittings to greatest extent possible.

## 2.6 INSULATING GLASS

- A. Basis of Design Manufacturers: Subject to compliance with requirements and where indicated as a basis of design manufacturer in glazing types below, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Viracon, Inc.
  - 2. Or approved equivalent.
- B. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
  - 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
  - 2. Spacer: Thermally broken stainless steel "warm edge" spacer in color selected by Architect from manufacturer's full range of standard and premium colors and finishes.
  - 3. Desiccant: Molecular sieve or silica gel, or a blend of both.
- C. Glass: Comply with applicable requirements in "Glass Products" Article and in "Laminated Glass" Article as indicated by designations in "Insulating-Glass Types" Article and in "Insulating-Laminated-Glass Types" Article.

## 2.7 FIRE-PROTECTION-RATED GLAZING

- A. Fire-Protection-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NRPA 252 for door assemblies and NFPA 257 for window assemblies.
- B. Laminated Ceramic Glazing: Laminated glass made from 2 piles of clear, ceramic flat glass; complying with testing requirements in 16 CFR 1201 for Category II materials.
  - 1. Basis of Design Product: Subject to compliance with requirements, provide the following:
    - a. Nippon Electric Glass, Co., Ltd. (distributed by Technical Glass Products); FireLite Plus.
    - b. Thickness: 5/16 inch [8 mm] overall.
    - c. Weight: 4 lbs./sq. ft.
    - d. Approximate Visible Transmission: 85 percent.
    - e. Approximate Visible Reflection: 9 percent.
    - f. Fire-rating: 20 minutes to 3 hours for doors; 20 minutes to 90 minutes for other applications.
    - g. Impact Safety Resistance: ANSI Z97.1 and CPSC 16 CFR 1201 (Cat. I and II).
    - h. STC Rating: Approximately 38 dB.
    - i. Surface Finish:
    - j. Premium Grade - Ground and polished on both sides
    - k. Positive Pressure Test: UL 10C, UBC 7-2 and 7-4; passes.
  - 2. To be used for fire rated door lights.
- C. Install in vision panels in fire-rated doors to requirements of NFPA 80.
- D. Fire Rating: Fire rating classified and labeled by UL for fire rating scheduled at opening locations on drawings, when tested in accordance with ASTM E2074-00 and ASTM E2010-01, NPFA 252 and NFPA 257, and UL 9, UL 10B and UL 10C.

## 2.8 GLAZING GASKETS

- A. Use only gaskets which glass manufacturers confirm is compatible with their products.
- B. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
  - 1. EPDM complying with ASTM C 864.
  - 2. Silicone complying with ASTM C 1115.
  - 3. Thermoplastic polyolefin rubber complying with ASTM C 1115.
- C. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned EPDM, silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
  - 1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

## 2.9 GLAZING SEALANTS

- A. General:
  - 1. Compatibility: Compatible with one another and with other materials they 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.
  - 3. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range of standard and premium colors.

- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
  - 1. Confirm compatibility with interlayers of laminated glass.
  - 2. Confirm compatibility with seals of insulated glass units.
  - 3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Dow Corning Corporation; 799.
    - b. Or approved equivalent.
  - 4. Confirm compatibility with interlayers of laminated glass.
  - 5. Confirm compatibility with seals of insulated glass units.
- C. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

## 2.10 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; 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; and complying with ASTM C1281 and AAMA 800 for products indicated below:
  - 1. AAMA 804.3 tape, where indicated.
  - 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
  - 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
  - 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
  - 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

## 2.11 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, with 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 of 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).
- F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- G. UV Filter Film:
  - 1. Basis of Design: Solarzone UV Filter Film or approved equivalent.
    - a. Visible Light Transmitted: 87%.

- b. UV Radiation Rejected: 99.8%.

## **2.12 FABRICATION OF GLAZING UNITS**

- A. Fabricate glazing units in sizes required to fit 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.
  - 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
    - a. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- C. Grind smooth and polish exposed glass edges and corners.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
  - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
  - 2. Presence and functioning of weep systems.
  - 3. Minimum required face and edge clearances.
  - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

### **3.3 GLAZING, GENERAL**

- A. 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.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. 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.

- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches.
  1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
  2. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. 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.
- H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

### **3.4 TAPE GLAZING**

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. 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.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. 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.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

### **3.5 GASKET GLAZING (DRY)**

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. 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.

- C. Installation with Drive-in Wedge Gaskets: 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.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

### 3.6 SEALANT GLAZING (WET)

- A. 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.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

### 3.7 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
  - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

### 3.8 MONOLITHIC AND LAMINATED GLASS SCHEDULE

- A. Glass Type: **GL 1** – ¼" Clear Float Glass
  - 1. Thickness: 6.0 mm.
  - 2. Heat-strengthened or fully tempered, as required by location and use in the building.
  - 3. Provide safety glazing labeling where appropriate.
  - 4. Uses include, but may not be limited to, interior doors and framed glass partitions.
- B. Glass Type: **GL 2** – ¼" Clear Float Glass with Ceramic Coating
  - 1. Thickness: 6.0 mm.
  - 2. Ceramic Coating Color and Pattern: Simulated Acid Etch, "V1085" as manufactured by Viracon or an approved equivalent.



3. Coating Location: Second Surface.
  4. Heat-strengthened or fully tempered, as required by location and use in the building.
  5. Provide safety glazing labeling where appropriate.
  6. Uses include, but may not be limited to, interior doors, framed glass partitions and millwork.
  7. Glass edge finish: Polished only where noted in the Drawings.
- C. Glass Type **GL 3** – 5/16” Fire-rated glass.
1. See item 2.7 in this specification section.
- D. Glass Type **GL 4** – 9/16” Clear Laminated Glass with Ceramic Coating
1. Laminated glass with two plies of heat-strengthened float glass
  2. Thickness of each glass ply: 6.0 mm.
  3. Interlayer construction: PVB suitable for exterior exposure of glass edge.
  4. Interlayer thickness: 0.060 inch.
  5. Ceramic Coating Color and Pattern: V1085 Simulated Acid Etch, by Viracon or approved equivalent.
  6. Coating Location: **#2 Surface**
  7. Glass edge finish: Polished.
  8. Provide minimum thickness of glazing listed, or as required to meet all delegated design and glass performance requirements.
  9. Uses include, but may not be limited to, exterior glass fins attached to curtain wall.
- E. Glass Type **GL 5** – 9/16” Clear Laminated Glass with Ceramic Coating
1. Laminated glass with two plies of heat-strengthened float glass
  2. Thickness of each glass ply: 6.0 mm.
  3. Interlayer construction: PVB suitable for exterior exposure of glass edge.
  4. Interlayer thickness: 0.060 inch.
  5. Ceramic Coating Color and Pattern: 1/16” wide vertical lines; **V948 Medium Gray**; 30% coverage
  6. Coating Location: **#2 Surface**
  7. Pattern to match IGUs in curtain wall installed above.
  8. Glass edge finish: Polished.
  9. Provide minimum thickness of glazing listed, or as required to meet all delegated design and glass performance requirements.
  10. Uses include, but may not be limited to, suspended glass skirt at bottom of curtain wall.
- F. Glass Type **GL 6** – 3/4” Clear Laminated/Tempered Glass
1. Laminated and tempered clear glass.
  2. Glass edge finish: Polished.
  3. Provide minimum thickness of glazing listed, or as required to meet all delegated design and glass performance requirements for guard rails.
  4. Uses include, but may not be limited to, Lobby Security Railing and Stair A Guardrail.
  5. See Division 05 Section “Decorative Metal Stairs & Railings” for performance criteria and base shoe installation information.
- G. Glass Type **GL 7** – 1/4” Clear Laminated Glass
1. Laminated glass with two plies of heat-strengthened float glass
  2. Thickness of each glass ply: 3.0 mm.
  3. Interlayer construction: PVB.
  4. Interlayer thickness: 0.060 inch.
  5. Ultra Violet Transmittance: less than 1%.
  6. Provide minimum thickness of glazing listed, or as required to meet all delegated design and glass performance requirements.
  7. Uses include, but may not be limited to, Special Collections display case and glass book case doors.
- H. Glass Type **GL 8** – 1/2” Clear Tempered Glass
1. Tempered clear glass.

2. Glass edge finish: Polished where exposed.
  3. Provide minimum thickness of glazing listed, or as required to meet all delegated design and glass performance requirements for frameless glass partitions.
  4. Uses include, but may not be limited to, Study Room glass walls and doors.
  5. See Division 08 Section "All-Glass Entrances & Storefronts" for performance criteria, base and head shoe, and patch and rail fitting information.
- I. Glass Type **GL 9** – 5/8" Ultraclear Opaque Laminated/Tempered Glass
1. Laminated and tempered ultraclear glass.
  2. Interlayer Construction: opaque colored SGP for sealant compatibility.
    - a. Architect to select color from full range of standard and premium colors.
  3. Glass edge finish: Polished.
  4. Provide minimum thickness of glazing listed, or as required to meet all delegated design and glass performance requirements for point-supported glass.
  5. Uses include, but may not be limited to, Interior Lightwell Upper Skirt.
  6. See Division 05 Section "Glazed Interior Lightwell" for performance criteria and button fitting information.
- J. Glass Type **GL 10** – 5/8" Ultraclear Laminated/Tempered Glass
1. Laminated and tempered ultraclear glass.
  2. Interlayer Construction: SGP for sealant compatibility.
    - a. Architect to select color from full range of standard and premium colors.
  3. Glass edge finish: Polished.
  4. Provide minimum thickness of glazing listed, or as required to meet all delegated design and glass performance requirements for shoe-supported glass.
  5. Uses include, but may not be limited to, Interior Lightwell Middle Storefront.
  6. See Division 05 Section "Glazed Interior Lightwell" for performance criteria and top and bottom structural shoes for glass installation.
- K. Glass Type **GL 11** – 5/8" Ultraclear (Opaque to Clear) Low Iron Laminated/Tempered Glass
1. Laminated and tempered ultraclear glass.
  2. Interlayer Construction:SGP for sealant compatibility.
    - a. Interlayer to gradually blend from 100% opaque at the top of the skirt to 0% at the bottom of the skirt. See Drawings for gradient transition locations.
    - b. Architect to select color from full range of standard and premium colors.
  3. Glass edge finish: Polished.
  4. Provide minimum thickness of glazing listed, or as required to meet all delegated design and glass performance requirements for point-supported glass.
  5. Uses include, but may not be limited to, Interior Lightwell Lower Skirt.
  6. See Division 05 Section "Glazed Interior Lightwell" for performance criteria and button fitting information.
- L. Glass Type **GL 12** – 1/4" Opaque Laminated Glass
1. Laminated glass with two plies of heat-strengthened float glass
  2. Thickness of each glass ply: 3.0 mm.
  3. Interlayer construction: opaque colored PVB.
    - a. Architect to select color from full range of standard and premium colors.
  4. Interlayer thickness: 0.060 inch.
  5. Ultra Violet Transmittance: less than 1%.
  6. Provide minimum thickness of glazing listed, or as required to meet all delegated design and glass performance requirements.
  7. Uses include, but may not be limited to, Special Collections display case and glass book case doors.
- M. Glass Type **GL 13** – 1/4" Clear Tempered Laminated Glass
1. Laminated glass with two plies of tempered float glass
  2. Thickness of each glass ply: 3.0 mm.
  3. Interlayer construction: SGP for sealant compatibility.
  4. Interlayer thickness: 0.060 inch.

5. Uses include, but may not be limited to, interior vestibule glazing and doors.

### 3.9 FIRE RATED STOREFRONT/DOOR GLAZING SCHEDULE

- A. Fire Rated Storefront/Door Glazing Type FR 1 – 90 minutes.
  1. See Division 08 Section “Fire Rated Storefront & Doors.”
- B. Fire Rated Storefront/Door Glazing Type FR 2 – 120 minutes.
  1. See Division 08 Section “Fire Rated Storefront & Doors.”

### 3.10 INSULATING GLASS SCHEDULE

- A. For each of the following glass types, provide product listed or an approved equivalent. All products shall comply with ASTM Standards and requirements in previous sections.
- B. Insulating Glass Type **IGU 1** – 1” Low-E-Coated, Clear
  1. Basis of Design: **1” IGU** “Solarscreen Low-E (VE) Insulating Glass with Argon Gas VE 1-2M” as manufactured by Viracon.
  2. Overall Unit Thickness: 1 inch.
  3. Thickness of Each Glass Lite: 6.0 mm.
  4. Outdoor Lite: Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by applicable building code and the CPSC safety glazing requirements.
  5. Interspace Content: Argon.
  6. Indoor Lite: Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by applicable building code and the CPSC safety glazing requirements.
  7. Low-E Coating: Sputtered on second surface.
  8. Visible Light Transmittance: 70 percent minimum.
  9. Solar Energy Transmittance: 33%
  10. Ultra Violet Transmittance (300 – 380 nm): 10%
  11. Winter Nighttime U-Factor: 0.25 Btu/(hr x sqft x deg F) maximum.
  12. Summer Daytime U-Factor: 0.21 Btu/(hr x sqft x deg F) maximum.
  13. Solar Heat Gain Coefficient: 0.37 maximum.
  14. Uses include, but may not be limited to, typical punched openings in slate facades and east bay window.
- C. Insulating Glass Type **IGU 2** – 1” Low-E-Coated, Clear, UV-Blocking film
  1. Basis of Design: “Solarscreen Low-E (VE) Insulating Laminated Glass VE 1-2M” as manufactured by Viracon.
  2. Overall Unit Thickness: 1 inch.
  3. Thickness of Outdoor Lite: 6.0 mm.
  4. Outdoor Lite: Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by applicable building code and the CPSC safety glazing requirements.
  5. Interspace Content: Argon.
  6. Indoor Lite: Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by applicable building code and the CPSC safety glazing requirements.
  7. Low-E Coating: Sputtered on second surface.
  8. UV-Blocking Film: Solarzone UV Filter Film applied to fourth surface.
  9. Visible Light Transmittance: 70 percent minimum, before film is added.
  10. Solar Energy Transmittance: 33%
  11. Ultra Violet Transmittance (300 – 380 nm): 10%
  12. Winter Nighttime U-Factor: 0.25 Btu/(hr x sqft x deg F) maximum.
  13. Summer Daytime U-Factor: 0.21 Btu/(hr x sqft x deg F) maximum.
  14. Solar Heat Gain Coefficient: 0.37 maximum.
  15. Uses include, but may not be limited to, exterior glazed openings in Special Collections department spaces.

- D. Insulating Glass Type **IGU 3** – 1” High Performance Low-E Coated, Clear
1. Basis of Design: VRE1-43 as manufactured by Viracon.
  2. Overall Unit Thickness: 1 inch.
  3. Thickness of Each Glass Lite: 6.0 mm.
  4. Outdoor Lite: Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by applicable building code and the CPSC safety glazing requirements.
  5. Interspace Content: 1/2" aluminum airspace, painted black, argon filled
  6. Indoor Lite: Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by applicable building code and the CPSC safety glazing requirements.
  7. Low-E Coatings: VRE-43 on #2 Surface, Roomside Low-E on #4 Surface.
  8. Visible Light Transmittance: **43 %**
  9. Exterior Reflectance: 25%
  10. Ultra Violet Transmittance (300 – 380 nm): **7%**
  11. Winter Nighttime U-Factor: **0.20** Btu/(hr x sqft x deg F) maximum.
  12. Summer Daytime U-Factor: **0.17** Btu/(hr x sqft x deg F) maximum.
  13. Solar Heat Gain Coefficient: **0.21** maximum.
  14. Uses include, but may not be limited to, curtain wall at the Northwest corner, Entry, ITS, Café, Stair B and Southwest Level 1.
- E. Insulating Glass Type **IGU 4** – 1” High Performance Low-E Coated, with Ceramic Coat
1. Basis of Design: VRE1-43 as manufactured by Viracon.
  2. Overall Unit Thickness: 1 inch.
  3. Thickness of Each Glass Lite: 6.0 mm.
  4. Outdoor Lite: Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by applicable building code and the CPSC safety glazing requirements.
  5. Interspace Content: Argon.
  6. Indoor Lite: Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by applicable building code and the CPSC safety glazing requirements.
  7. Low-E Coatings: VRE-43 on #2 Surface, Roomside Low-E on #4 Surface.
  8. Ceramic Vertical Line Coating
    - a. Location: Second surface.
    - b. Line size: 1/16 inch wide
    - c. Line color: Medium gray, Viracon V948.
    - d. Pattern: 30% coverage
  9. Visible Light Transmittance: **30** percent minimum.
  10. Exterior Reflectance: 22%
  11. Ultra Violet Transmittance (300 – 380 nm): **3%**
  12. Winter Nighttime U-Factor: **0.20** Btu/(hr x sqft x deg F) maximum.
  13. Summer Daytime U-Factor: **0.17** Btu/(hr x sqft x deg F) maximum.
  14. Solar Heat Gain Coefficient: **0.16** maximum.
  15. Uses include, but may not be limited to, curtainwall at the South and Southwest.
- F. Insulating Glass Type **IGU 5** – 1” High Performance Spandrel
1. Basis of Design: VRE1-43 as manufactured by Viracon.
  2. Overall Unit Thickness: 1 inch.
  3. Thickness of Each Glass Lite: 6.0 mm.
  4. Outdoor Lite: Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by applicable building code and the CPSC safety glazing requirements.
  5. Interspace Content: Argon.
  6. Indoor Lite: Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by applicable building code and the CPSC safety glazing requirements.
  7. Low-E Coatings: VRE-43 on #2 Surface
  8. Ceramic Spandrel Coating

- a. Location: #4 Surface
  - b. Color: Medium gray, Viracon V948.
  - c. Coverage: 100%.
  - 9. Winter Nighttime U-Factor: 0.25 Btu/(hr x sqft x deg F) maximum.
  - 10. Summer Daytime U-Factor: 0.21 Btu/(hr x sqft x deg F) maximum.
  - 11. Uses include, but may not be limited to, curtainwall spandrel at the Northwest corner and east bay curtainwall.
- G. Insulating Glass Type **IGU 6** – 1-5/16” High Performance, Laminated & Tempered, with Ceramic Coating
- 1. Basis of Design: VRE1-43 as manufactured by Viracon.
  - 2. Overall Unit Thickness: 1-5/16 inch MAXIMUM.
  - 3. Thickness of Each Glass Lite: 6.0 mm.
  - 4. Outdoor Lite: Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by applicable building code and the CPSC safety glazing requirements.
  - 5. Interspace Content: Argon.
  - 6. Indoor Lite: Clear laminated glass with two plies of Heat-strengthened float glass, except that fully tempered glass shall be provided at all locations required by applicable building code and the CPSC safety glazing requirements.
    - a. Thickness of Each Glass Ply: 6.0 mm.
    - b. Interlayer Thickness: 0.030 inch.
  - 7. Low-E Coatings: VRE-43 on #2 Surface, Roomside Low-E on #6 Surface.
  - 8. Ceramic Dot Coating
    - a. Location: Second surface.
    - b. Dot size: 1/8 inch diameter.
    - c. Dot color: Medium gray, Viracon V948.
    - d. Pattern: 50% coverage
  - 9. Visible Light Transmittance: 29% minimum.
  - 10. Exterior Reflectance: 22%
  - 11. Ultra Violet Transmittance (300 – 380 nm): 0%
  - 12. Winter Nighttime U-Factor: 0.20 Btu/(hr x sqft x deg F) maximum.
  - 13. Summer Daytime U-Factor: 0.16 Btu/(hr x sqft x deg F) maximum.
  - 14. Solar Heat Gain Coefficient: 0.16 maximum.
  - 15. Uses include, but may not be limited to, sloped glazing.

### 3.11 WASTE MANAGEMENT

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction. Separate tempered glass waste for use as aggregate of nonstructural fill.
- C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 08 80 00**

## **SECTION 08 91 19 - FIXED LOUVERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Drainable fixed extruded-aluminum louvers.
  - 2. Blank-off panels for louvers.
  - 3. Bird screens, structural supports and attachment brackets.
- B. Related sections include:
  - 1. Division 07 Section "Joint Sealants" for sealants installed in perimeter joints between louver frames and adjoining construction.

#### **1.3 REFERENCES**

- A. Air Movement and Control Association International, Inc.
  - 1. AMCA Standard 500-L Laboratory Methods of Testing Louvers for Rating
  - 2. AMCA Publication 501 Application Manual for Louvers
- B. The Aluminum Association Incorporated
  - 1. Aluminum Standards and Data
  - 2. Specifications and Guidelines for Aluminum Structures
- C. American Society of Civil Engineers
  - 1. Minimum Design Loads for Buildings and Other Structures
- D. American Society for Testing and Materials
  - 1. ASTM B209
  - 2. ASTM B211
  - 3. ASTM B221
  - 4. ASTM E90-90
- E. Architectural Aluminum Manufacturers Association
  - 1. AAMA 800 Voluntary Specifications and Test Methods for Sealants
  - 2. AAMA 605.2 Voluntary Specification for High Performance Organic Coatings on Aluminum Extrusions and Panels.
  - 3. AAMA TIR Metal Curtain Wall Fasteners
  - 4. AAMA 2605-98 Superior Performing Organic Coatings on Aluminum Extrusions and Panels
- F. Canadian Standards Association
  - 1. CAN3-S157-M83 Strength Design in Aluminum
  - 2. S136 94 Cold Formed Steel Structural Members

#### **1.4 DEFINITIONS**

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades (i.e., the axis of the blades are horizontal).

- C. Vertical Louver: Louver with vertical blades (i.e., the axis of the blades are vertical).
- D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing according to AMCA 500-L.
- F. Windborne-Debris-Impact-Resistant Louver: Louver that provides specified windborne-debris-impact resistance, as determined by testing according to AMCA 540.

## **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
  - 1. Show weep paths, gaskets, flashings, sealants, and other means of preventing water intrusion.
  - 2. Show mullion profiles and locations.
- C. Samples: For each type of metal finish required.

## **1.6 INFORMATIONAL SUBMITTALS**

- A. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.
- B. Air flow, water entrainment performance and indborne-debris-impact-resistance test reports.
- C. Sample Warranties: For manufacturer's special warranties.

## **1.7 QUALITY ASSURANCE**

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
  - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
  - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."
- B. Single subcontract responsibility: Subcontract the work to a single firm that has had not less than six years experience in the design and manufacturing of work similar to that shown and required.
- C. Performance Requirements: Provide AMCA and BSRIA test data as required to confirm that the louvers have the specified air and water performance characteristics.
- D. Acoustical Performance: Where applicable, submit test reports to confirm that the louvers meet the specified STC and Noise Reduction requirements.
- E. Structural Requirements: Design all materials to withstand wind and snow loads as required by the applicable building code. Maximum allowable deflection for the louver structural members to be l/180 or 0.75 inch, whichever is less. Maximum allowable deflection for the louver blades to be l/120 or 0.50 inch across the weak axis, whichever is less.

- F. Professional Engineer Requirements: Drawings and structural calculations to be signed and sealed by a professional engineer licensed to practice in the project state.
- G. Warranty: Provide written warranty to the owner that all products will be free of defective materials or workmanship for a period of one year from date of installation.
- H. Products in this section may be included in freestanding mockups.

## **1.8 FIELD CONDITIONS**

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

## **1.9 WARRANTY**

- A. Special Finish Warranty: Manufacturer agrees to repair or replace components on which finishes fail in materials or workmanship within specified warranty period.
  - 1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
  - 2. Warranty Period: 20 years from date of Substantial Completion.

## **1.10 DELIVERY, STORAGE AND HANDLING**

- A. Delivery: At the time of delivery all materials shall be visually inspected for damage. Any damaged boxes, crates, louver sections, etc. shall be noted on the receiving ticket and immediately reported to the shipping company and the material manufacturer.
- B. Storage:
  - 1. Material may be stored flat, on end or on its side.
  - 2. Material may be stored either indoors or outdoors.
  - 3. If stored outdoors the material must be raised sufficiently off the ground to prevent it being flooded.
  - 4. If stored out doors the material must be covered with a weather proof flame resistant sheeting or tarpaulin.
- C. Handling:
  - 1. Material shall be handled in accordance with sound material handling practices and in such a way as to minimize racking.
  - 2. Louver sections may be hoisted by attaching straps to the jambs and lifting the section while it is in a vertical position.
  - 3. Louver sections should only be lifted and carried by the jambs. Heads, sills and blades are not to be used for lifting or hoisting louver sections.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Source Limitations: Obtain fixed louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

### **2.2 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.



- B. Structural Performance: Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.
  - 1. Wind Loads: Determine loads based on pressures as indicated on Drawings.
- C. Windborne-Debris-Impact Resistance: Louvers located within 30 feet of grade shall pass basic protection, when tested according to AMCA 540.
- D. Seismic Performance: As indicated on drawings.
- E. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- G. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

### 2.3 DRAINABLE FIXED EXTRUDED-ALUMINUM LOUVERS

- A. Basis of Design: CS 4" Drainable Fixed Extruded Louver Model A4177 manufactured by Construction Specialties, Inc, or approved equivalent.
  - 1. **Material:** Heads, sills, jambs and mullions to be one piece structural aluminum members with integral caulking slot and retaining beads. Mullions shall be sliding interlock with internal drains. Blades to be one piece aluminum extrusions with gutters designed to catch and direct water to jamb and mullion drains. Compression gaskets shall be provided between bottom of mullion or jamb and top of sill to insure leak tight connections. Material thickness to be as follows: Heads: 0.070"; Sills: 0.080"; Jambs and Mullions: 0.125"; Fixed Blades: 0.070".
  - 2. **AMCA Performance:** A 4' x 4' unit shall conform to the following:
    - a. Free Area : 8.80 sq ft
    - b. Free area velocity at the point of beginning water penetration: 1087 FPM
    - c. Intake Pressure drop at the point of beginning water penetration: 0.18 in. H<sub>2</sub>O
    - d. Exhaust Pressure drop at the point of beginning water penetration: 0.15 in. H<sub>2</sub>O

### 2.4 FINISHES

- A. General: Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise indicated. Apply finishes in factory. Protect finishes on exposed surfaces prior to shipment. Remove scratches and blemishes from exposed surfaces that will be visible after completing finishing process. Provide color as indicated or, if not otherwise indicated, as selected by architect.
- B. Three Coat Fluorocarbon Coating
  - 1. Louvers to be finished with a minimum 1.4 mil (0.035mm) thick full strength 70% resin, 3 coat Fluoropolymer system.

2. All aluminum shall be thoroughly cleaned, etched and given a chromated conversion pre-treatment before application of the Kynar/Hylar coating. The coating shall consist of a primer, a high metallic color coat and a clear PVF2 topcoat. It shall receive a bake cycle of 17 minutes at 450°F. All finishing procedures shall be one continuous operation in the plant of the manufacturer.
3. Manufacturer to furnish an extended 20 limited warranty for the Kynar/Hylar coating. This limited warranty shall begin on the date of material shipment.

## 2.5 BIRD SCREENS

- A. Unless otherwise indicated, all louvers to be furnished with mill finish bird or insect screens.
- B. Screens to be 5/8" (15.9mm) mesh, 0.050" (1.27mm) thick expanded and flattened aluminum bird screen secured within 0.055" (1.40mm) thick extruded aluminum frames. Frames to have mitered corners and corner locks.

## 2.6 BLANK-OFF PANELS

- A. Furnish where indicated on the drawings blank-off panels fabricated by the louver manufacturer.
- B. Blank-off panels to be 2" (50.8mm) thick and to be faced on both sides with 0.032" (0.81 mm) thick aluminum sheet. Panels to be fabricated with an expanded polystyrene (EPS) core having an R-value of 8 (°F\*ft<sup>2</sup>\*h/Btu). Panel perimeter frame to be 0.050" (1.27mm) thick-formed aluminum channels. Panel frame to be mitered at the corners. Panels to be finished to match louvers.

## 2.7 MATERIALS

- A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
  1. Use Phillips flat-head tamper-resistant screws for exposed fasteners unless otherwise indicated.
  2. For fastening aluminum, use aluminum or 300 series stainless-steel fasteners.
  3. For color-finished louvers, use fasteners with heads that match color of louvers.
- D. Postinstalled Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless-steel components, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing according to ASTM E488/E488M conducted by a qualified testing agency.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

## 2.8 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
  1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern unless horizontal mullions are indicated.

- C. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.
- D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
  - 1. Frame Type: Channel unless otherwise indicated.
- E. Include supports, anchorages, and accessories required for complete assembly.
- F. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or 72 inches o.c., whichever is less.
  - 1. Fully Recessed Mullions: Where indicated, provide mullions fully recessed behind louver blades. Where length of louver exceeds fabrication and handling limitations, fabricate with close-fitting blade splices designed to permit expansion and contraction.
  - 2. Exterior Corners: Prefabricated corner units with mitered and welded blades and with fully recessed mullions at corners.
- G. Provide subsills made of same material as louvers for recessed louvers.
- H. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine openings to receive the work. Do not proceed until any unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. Comply with manufacturer's instructions and recommendations for installation of the work.
- B. Verify dimensions of supporting structure at the site by accurate field measurements so that the work will be accurately designed, fabricated and fitted to the structure.
- C. Anchor louvers to the building substructure as indicated on architectural drawings.
- D. Erection Tolerances:
  - 1. Maximum variation from plane or location shown on the approved shop drawings: 1/8" per 12 feet of length, but not exceeding 1/2" in any total building length or portion thereof (non-cumulative).
  - 2. Maximum offset from true alignment between two members abutting end to end, edge-to-edge in line or separated by less than 3": 1/16" (shop or field joints). This limiting condition shall prevail under both load and no load conditions.
- E. Cut and trim component parts during erection only with the approval of the manufacturer or fabricator, and in accordance with his recommendations. Restore finish completely. Remove and replace members where cutting and trimming has impaired the strength or appearance of the assembly.
- F. Do not erect warped, bowed, deformed or otherwise damaged or defaced members. Remove and replace any members damaged in the erection process as directed.
- G. Set units level, plumb and true to line, with uniform joints.

### **3.3 PROTECTION**

- A. Protect installed materials to prevent damage by other trades. Use materials that may be easily removed without leaving residue or permanent stains.

### **3.4 ADJUSTMENT & CLEANING**

- A. Immediately clean exposed surfaces of the louvers to remove fingerprints and dirt accumulation during the installation process. Do not let soiling remain until the final cleaning.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to the material finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers and accessory components damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by the Architect, remove damaged materials and replace with new materials.
  - 1. Touch up minor abrasions in finishes with a compatible air-dried coating that matches the color and gloss of the factory applied coating.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 08 91 19**

## **SECTION 09 21 17 - GYPSUM BOARD SHAFT WALL ASSEMBLIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes gypsum board shaft wall assemblies.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each component of gypsum board shaft wall assembly.

#### **1.4 DELIVERY, STORAGE, AND HANDLING**

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and support them on risers on a flat platform to prevent sagging.

#### **1.5 FIELD CONDITIONS**

- A. Environmental Limitations: Comply with gypsum-shaftliner-board manufacturer's written instructions.
- B. Do not install finish panels until installation areas are enclosed and conditioned.
- C. Do not install 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.

### **PART 2 - PRODUCTS**

#### **2.1 PERFORMANCE REQUIREMENTS**

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.

#### **2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES**

- A. Fire-Resistance Rating: 2 hours.
- B. Gypsum Shaftliner Board:
  - 1. Type X: ASTM C1396/C1396M; manufacturer's proprietary fire-resistive liner panels with paper faces, 1 inch thick, with double beveled long edges.
  - 2. Moisture- and Mold-Resistant Type X: ASTM C1396/C1396M; manufacturer's proprietary fire-resistive liner panels with ASTM D3273 mold-resistance score of 10 as rated according to ASTM D3274, 1 inch thick, and with double beveled long edges.
    - a. Use moisture and mold resistant Type X board in mechanical spaces and shafts.

- C. Non-Load-Bearing Steel Framing, General: Complying with ASTM C645 requirements for metal unless otherwise indicated and complying with requirements for fire-resistance-rated assembly indicated.
  - 1. Protective Coating: ASTM A653/A653M, G60, hot-dip galvanized unless otherwise indicated.
- D. Studs: Manufacturer's standard profile for repetitive, corner, and end members as follows:
  - 1. Depth and Gauge: As required for spans indicated on Drawings.
- E. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches long and matching studs in depth.
  - 1. Minimum Base-Metal Thickness: Matching steel studs.
- F. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- G. Elevator-Hoistway-Entrance Struts: Manufacturer's standard J-profile jamb strut with long-leg length of 3 inches, matching studs in depth, and not less than 0.033 inch thick.
- H. Finish Panels: Gypsum board as specified in Division 09 Section "Gypsum Board."
- I. Sound Attenuation Blankets: As specified in Division 09 Section "Gypsum Board."

## **2.3 AUXILIARY MATERIALS**

- A. General: Provide auxiliary materials that comply with shaft wall manufacturer's written instructions.
- B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in Division 09 Section "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written instructions for application indicated.
- C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
- D. 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. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E488/E488M conducted by a qualified testing agency.
  - 2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E1190 conducted by a qualified testing agency.
- E. Acoustical Sealant: Division 09 Section "Gypsum Board"

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 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."
- 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.

### **3.3 INSTALLATION**

- A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated and manufacturer's written installation instructions.
- B. Do not bridge 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, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.
  - 1. Elevator Hoistway: At elevator hoistway-entrance door frames, provide jamb struts on each side of door frame.
  - 2. Reinforcing: Provide where items attach directly to shaft wall assembly as indicated on Drawings and as required; accurately position and secure behind at least one layer of face panel.
- D. Penetrations: 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 and floor indicators, and similar items.
- E. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels while maintaining continuity of fire-rated construction.
- F. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
- G. Control Joints: Install control joints according to ASTM C840 and in specific locations approved by Architect while maintaining fire-resistance rating of gypsum board shaft wall assemblies.
- H. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

### **3.4 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.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  1. Aluminum
  2. Plastic Materials and Gaskets
  3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 09 21 17**



## **SECTION 09 22 16 - NON-STRUCTURAL METAL FRAMING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Non-load-bearing steel framing systems for interior partitions.
  - 2. Suspension systems for interior ceilings and soffits.
  - 3. Grid suspension systems for gypsum board ceilings.
- B. Related Requirements:
  - 1. Division 05 Section "Cold-Formed Metal Framing" for exterior and interior load-bearing and exterior non-load-bearing wall studs.

#### **1.3 ACTION SUBMITTALS**

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

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Product Certificates: For each type of code-compliance certification for studs and tracks.
- B. Evaluation Reports: For firestop tracks post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

### **PART 2 - PRODUCTS**

#### **2.1 PERFORMANCE REQUIREMENTS**

- 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 E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated on Drawings, according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

#### **2.2 FRAMING SYSTEMS**

- A. Framing Members, General: Comply with ASTM C754 for conditions indicated.
  - 1. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.
  - 2. Protective Coating: ASTM A653/A653M, G60, hot-dip galvanized unless otherwise indicated.
- B. Studs and Tracks: ASTM C645.
  - 1. Steel Studs and Tracks:
    - a. Minimum Base-Steel Thickness: 0.033 inch. Provide deeper or heavier gauge studs where ever the unbraced height exceeds the stud capacity to meet L/240 deflection requirements with a 5 psf wall load.
    - b. Depth: As indicated on Drawings or 3-5/8 inches.

- A. Slip-Type Head Joints: At all non-fire-rated partitions, provide one of the following:
  - 1. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch-deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
  - 2. 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.
- B. Firestop Tracks: Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
- C. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
  - 1. Minimum Base-Metal Thickness: 0.033 inch.
- D. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-metal thickness, with minimum 1/2-inch-wide flanges.
  - 1. Depth: 1-1/2 inches.
  - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch-thick, galvanized steel.
- E. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
  - 1. Minimum Base-Metal Thickness: 0.033 inch.
  - 2. Depth: 7/8 inch and 1½ inches as indicated on drawings.
- F. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission.
  - 1. Configuration: Asymmetrical or hat shaped.
- G. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges.
  - 1. Depth: 3/4 inch.
  - 2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.033 inch.
  - 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.

## 2.3 SUSPENSION SYSTEMS

- A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.
- B. Hanger Attachments to Concrete:
  - 1. Expansion Anchors: Fabricated from corrosion-resistant materials, with allowable load or strength design capacities calculated according to ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing per ASTM E 488/E 488M conducted by a qualified testing agency.
  - 2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with allowable load capacities calculated according to ICC-ES AC70, greater than or equal to the design load, as determined by testing per ASTM E 1190 conducted by a qualified testing agency.
- C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.
- D. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch and minimum 1/2-inch-wide flanges.
  - 1. Depth: 1-1/2 inches.
- E. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.0538-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
  2. Steel Studs and Runners: ASTM C 645.
    - a. Minimum Base-Metal Thickness: 0.033 inch.
    - b. Depth: 3-5/8 inches.
  3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
    - a. Minimum Base-Metal Thickness: 0.033 inch.
- F. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.

## **2.4 AUXILIARY MATERIALS**

- A. General: Provide auxiliary materials that comply with referenced installation standards.
1. Fasteners for Steel 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 thick, in width to suit steel stud size.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.
- B. Coordination with Sprayed Fire-Resistive Materials:
1. Before sprayed fire-resistive materials are applied, attach offset anchor plates or ceiling 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 o.c.
  2. After sprayed fire-resistive materials are applied, remove them only to extent necessary for installation of non-load-bearing steel framing. Do not reduce thickness of fire-resistive materials below that are required for fire-resistance ratings indicated. Protect adjacent fire-resistive materials from damage.

### **3.3 INSTALLATION, GENERAL**

- A. Installation Standard: ASTM C754.
1. Gypsum Board Assemblies: Also comply with requirements in ASTM C840 that apply to framing installation.
- B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

- C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- D. Install bracing at terminations in assemblies.
- E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

### **3.4 INSTALLING FRAMED ASSEMBLIES**

- A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
  - 1. Single-Layer Application: 16 inches o.c. unless otherwise indicated.
  - 2. Multilayer Application: 16 inches o.c. unless otherwise indicated.
  - 3. Tile Backing Panels: 16 inches o.c. unless otherwise indicated.
- B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- C. Install studs so flanges within framing system point in same direction.
- D. Install tracks 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 that penetrate 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 track section (for cripple studs) at head and secure to jamb studs.
    - a. Install two studs at each jamb unless otherwise indicated.
    - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    - c. 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.
- E. Direct Furring:
  - 1. Screw to wood framing.
  - 2. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

### **3.5 INSTALLING CEILING SUSPENSION SYSTEMS**

- A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.
  - 1. Hangers: 48 inches o.c.

2. Carrying Channels (Main Runners): 48 inches o.c.
  3. Furring Channels (Furring Members): 16 inches o.c.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. 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. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
  4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
  5. Do not attach hangers to steel roof deck.
  6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
  7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
  8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- F. 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.
- G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

### **3.6 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
1. Aluminum
  2. Steel
  3. Plastic Materials
  4. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 09 22 16**

## **SECTION 09 29 00 - GYPSUM BOARD**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Interior gypsum board.
  - 2. Tile backing panels.
  - 3. Interior gypsum board for painted finish.
  - 4. Reveal trims and other trim pieces for painted gypsum surfaces.
  - 5. Sound attenuation blanket.
  - 6. Steel deck infill and closure pieces for acoustics.
  - 7. Acoustic joint sealant.
- B. Related Requirements:
  - 1. Division 06 Section "Sheathing" for gypsum sheathing for exterior walls and interior walls.
  - 2. Division 09 Section "Gypsum Board Shaft Wall Assemblies" for metal shaft-wall framing, gypsum shaft liners, and other components of shaft-wall assemblies.
  - 3. Division 09 Section "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
  - 4. Division 09 Section "Acoustical Panel Ceilings" for acoustical and drywall transition moldings.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Samples: For the following products:
  - 1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.
- C. Samples for Initial Selection: For each type of trim accessory indicated.
- D. Samples for Verification: For the following products:
  - 1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.
  - 2. FRP samples.

#### **1.4 QUALITY ASSURANCE**

- A. Mockups: Build mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and to set quality standards for materials and execution.
  - 1. Build mockups for the following:
    - a. Each level of gypsum board finish indicated for use in exposed locations.
    - b. Each reveal and trim specified; 10 linear feet minimum each type.
    - c. In-place mockup locations to be determined during pre-install meeting with Architect.
  - 2. Simulate finished lighting conditions for review of mockups.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

- B. 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.
  - 1. All rated construction shall be continuous from concrete slab to underside of floor/deck above.
- C. Tolerances: For aluminum trim, tolerances shall be as follows:
  - 1. Horizontal plane: Variation from level shall be no more than 1/8 inch in 12 feet. Variation in plane of adjacent wallboard panels prior to joint treatment shall not exceed 1/16 inch prior to joint treatment.
  - 2. Framed vertical construction:
    - a. Position: 1/4 inch maximum variation from design position.
    - b. Alignment: 1/8 inch in 8 feet maximum. 1/4 inch maximum in any continuous wall, line or surface.
    - c. Surface smoothness: No joint or fastener location, roughness or blemish discernible after application of finish when viewed at any angle from a distance of five feet under occupancy lighting conditions, with surface preparation as specified in Division 09 Section "Painting."

## **1.5 DELIVERY, STORAGE AND HANDLING**

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

## **1.6 FIELD CONDITIONS**

- A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install 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.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 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 E90 and classified according to ASTM E413 by an independent testing agency.

### **2.2 GYPSUM BOARD, GENERAL**

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

### **2.3 INTERIOR GYPSUM BOARD**

- A. Gypsum Wallboard: ASTM C1396/C1396M.

1. Thickness: ½ and 5/8 inch.
  2. Long Edges: Tapered.
- B. Gypsum Board, Type X: ASTM C1396/C1396M.
1. Thickness: ½ inch and 5/8 inch.
  2. Long Edges: Tapered.
- C. Gypsum Ceiling Board: ASTM C1396/C1396M.
1. Thickness: ½ and 5/8 inch.
  2. Long Edges: Tapered.
- D. Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
1. Core: As indicated ½ and 5/8 inch, regular type.
  2. Long Edges: Tapered.
  3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

## 2.4 TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M, with manufacturer's standard edges.
1. Core: 5/8" thickness, unless noted otherwise on Drawings.
  2. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

## 2.5 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047.
1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
  2. Shapes:
    - a. LC-Bead: J-shaped; exposed long flange receives joint compound.
    - b. Expansion (control) joint.
    - c. V-Control Joint: Expansion (control) joint.
  3. Tapered co-polymer structural laminate trim:
    - a. Basis of Design: Use trim pieces by No-Coat, or approved equivalent.
      - 1) L bead for ½" and 5/8" gyb
      - 2) Cornerbead, with flanges punched and spackled in.
- B. Aesthetic Effect: The Basis of Design Products listed herein establish not only performance standards, but also aesthetic standards which must be met by any other product to be considered an acceptable equal.
- C. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
1. Basis of Design Manufacturer: Subject to compliance with requirements, provide the products indicated below as manufactured by one of the following, or an approved equivalent:
    - a. Fry Reglet Corp.
    - b. Gordon, Inc.
    - c. Pittcon Industries.
    - d. MM Systems Corp.
  2. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B 221, Alloy 6063-T5.
  3. Finish: Manufacturer's standard factory spray and bake-on primer and final paint finish.
    - a. Custom colors to match adjacent wall paint.
    - b. Do not field paint any prefinished aluminum reveals.
  4. Shapes Used with GWB:
    - a. Where indicated "3/8" ALUM 'Z' REVEAL, PREFIN" in the Drawings, the Basis of Design product shall be the following Fry products:
      - 1) Fry DRMZ-50-375: ½" reveal depth x 3/8" reveal width.



- 2) Fry DRMZ-625-375: 5/8" reveal depth x 3/8" reveal width.
- 3) All Z reveals to be prefinished to match wall color. No field painting of Z reveals will be permitted.
- b. Where indicated "ALUM 'F' REVEAL, PREFIN" in the Drawings, the Basis of Design product shall be the following Fry products:
  - 1) Fry DRMF-50-25: 1/2" reveal depth x 1/4" reveal width.
- c. Where indicated "GWB 'L' TRIM MOLDING" in the Drawings, the Basis of Design product shall be:
  - 1) DRML-50 for 1/2" gwb.
  - 2) DRML-625 for 5/8" gwb.
  - 3) DRML-100 for 1" gwb.
- d. Where indicated "4" ALUM REVEAL BASE, PREFIN" in the Drawings, the Basis of Design product shall be Fry DRMB-50-400.
5. End Caps: Provide end caps with or without flanges as is appropriate for the termination conditions of all reveal trim.
6. No exposed fasteners in aluminum trim.
7. Fabrication:
  - a. Make custom miters and intersections with welded corners or with high strength industrial tape on backs.

## 2.6 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape:
  1. Interior Gypsum Board: Paper.
  2. Exterior Gypsum Soffit Board: Paper.
  3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
  4. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
  1. Prefilling: At open joints, rounded or beveled panel edges, 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.
    - a. Use setting-type compound for installing paper-faced metal trim accessories.
  3. Fill Coat: For second coat, use drying-type, all-purpose compound.
  4. Finish Coat: For third coat, use drying-type, all-purpose compound.
  5. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.
- D. Joint Compound for Tile Backing Panels:
  1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.

## 2.7 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Steel Drill Screws: ASTM C1002 unless otherwise indicated.
  1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
  2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- C. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from rock wool.

1. Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.
- D. Acoustic Foam Infills for Metal Deck:
1. Basis of Design: Provide type HFP1 individual foam closure plugs by O'Donnell Metal Deck, or approved equivalent.
  2. EPDM/SBR real rubber blend closure with fine closed-cell structure.
  3. Provide precut shape to fit each type of steel deck in project.
  4. Install at top of every partition to prevent sound transmission; length of plug to match thickness of partition.
  5. See Drawings for details.
- E. Metal Deck Closures:
1. Basis of Design: Provide metal closures manufactured by Western States Metal Roofing, or approved equivalent.
  2. Steel closure strips cut to the correct profile of each deck in the project.
  3. Install at every visible partition head, over acoustic infill.
  4. Seal with acoustical sealant. Use firestopping when required.
  5. See Drawings for details.
- F. Interior Acoustical Sealant (I/A): Manufacturers standard non-sag, paintable, non-staining latex sealant, complying with ASTM C 834. Product 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. Provide product manufactured by Sherman Williams, or approved equivalent.
    - a. Sherwin Williams Sher-Max Urethanized Elastomeric Sealant
  2. Acoustical sealant to be installed at both the top and bottom of all interior partitions, and at all penetrations through these partitions.
- G. Thermal Insulation: As specified in Division 07 Section "Thermal Insulation."

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 APPLYING AND FINISHING GYPSUM PANELS, GENERAL**

- A. Comply with ASTM C840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
  - 1. Coordinate locations of all expansion joints with Architect.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
  - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
  - 2. Fit gypsum panels around ducts, pipes, and conduits.
  - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch-wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch-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.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

### **3.3 APPLYING INTERIOR GYPSUM BOARD**

- A. Install interior gypsum board in the following locations:
  - 1. Wallboard Type: Vertical surfaces unless otherwise indicated.
  - 2. Type X: Install on all exterior walls to meet NFPA 285 wall assembly, and any interior fire rated wall assembly.
  - 3. Ceiling Type: Ceiling surfaces.
  - 4. Mold-Resistant Type: Install in toilet rooms, any room where FRP panels are to be installed, and in all mechanical spaces and chases.
- B. Single-Layer Application:
  - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
  - 2. On partitions/walls, apply gypsum panels horizontally (perpendicular to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
    - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
    - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
  - 3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Multilayer Application:
  - 1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.

2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers and face layers separately to supports with screws.

### **3.4 APPLYING TILE BACKING PANELS**

- A. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with 1/4-inch gap where panels abut other construction or penetrations.
- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

### **3.5 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 C840 and in specific locations approved by Architect for visual effect.
  1. All control joint locations must be approved by Architect.
- C. Interior Trim: Install in the following locations:
  1. Cornerbead: Use at outside corners spackled in.
  2. LC-Bead: Use at exposed panel edges.
  3. L-Bead: Use where indicated.
- D. Aluminum Trim: Install in locations where noted on the drawings, and any other similar circumstances shown on the drawings even if not specifically noted in every instance.
  1. Install trim in accord with manufacturer's product data and as follows:
    - a. Install "Alum 'Z' Reveal Molding" where GWB meets any other material including but not limited to stone, metal, slate. Review locations with Architect prior to installation.
    - b. Do not install reveal trim in fire rated or in STC-rated partitions.
    - c. Install with mechanical anchors spaced at 8 inches on center.
  2. Finish joints and attachment flanges with spackle, as described in this Section.
  3. Dust surfaces. Joint and fastener treatment shall be indistinguishable in finished work.
  4. Protect accessories from damage until date of Substantial Completion. Replace trim which may become damaged.

### **3.6 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 for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
  - 1. Level 1: Ceiling plenum areas and concealed areas.
  - 2. Level 2: Panels that are substrate for 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 Division 09 Section "Painting."
- E. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

### **3.7 PROTECTION**

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. 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.

### **3.8 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 09 29 00**

## **SECTION 09 30 13 - CERAMIC TILING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Glazed wall tile.
- B. Related Requirements:
  - 1. Division 07 Section "Joint Sealants" for sealing of expansion, contraction, control, and isolation joints in tile surfaces.
  - 2. Division 09 Section "Gypsum Board" for glass-mat, water-resistant backer board.

#### **1.3 DEFINITIONS**

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. ANSI A108 Series: ANSI A108.01, ANSI A108.02, ANSI A108.1A, ANSI A108.1B, ANSI A108.1C, ANSI A108.4, ANSI A108.5, ANSI A108.6, ANSI A108.8, ANSI A108.9, ANSI A108.10, ANSI A108.11, ANSI A108.12, ANSI A108.13, ANSI A108.14, ANSI A108.15, ANSI A108.16, and ANSI A108.17, which are contained in its "Specifications for Installation of Ceramic Tile."
- C. Module Size: Actual tile size plus joint width indicated.
- D. Face Size: Actual tile size, excluding spacer lugs.

#### **1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples for Initial Selection: For tile, grout, and accessories involving color selection.
- D. Samples for Verification:
  - 1. Full-size units of each type and composition of tile and for each color and finish required.
  - 2. Full-size units of each type of trim and accessory for each color and finish required.

#### **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.

- B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- C. Product Certificates: For each type of product.
- D. Product Test Reports: For tile-setting and -grouting products and certified porcelain tile.

### **1.7 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match and are from same production runs as 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.
  - 2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

### **1.8 QUALITY ASSURANCE**

- A. 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 mockup of each type of wall tile installation.
    - a. Install wall tile in Toilet Room 105: two adjacent walls including inside corner, base, and transition at top of wainscot from tile to gypsum wall board with gwb trim.
    - b. Simulate finished lighting conditions for review of mockups.
  - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

### **1.9 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 requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

### **1.10 FIELD CONDITIONS**

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
  - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.

- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
  - 1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.

## **2.2 PRODUCTS, GENERAL**

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
  - 1. Provide tile complying with Standard grade requirements unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.

## **2.3 TILE PRODUCTS**

- A. Ceramic Tile Type: Glazed wall tile.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide "Rittenhouse Square" as manufactured by Daltile, or approved equivalent.
  - 2. Module Size: 3 by 6 inches.
  - 3. Thickness: 5/16 inch.
  - 4. Face: Plain with modified square edges or cushion edges.
  - 5. Finish: Matte glaze.
  - 6. Tile Color: To be selected by Architect from manufacturer's full range.
  - 7. Pattern: Running bond.
  - 8. Grout Color: As selected by Architect from manufacturer's full range.
  - 9. Mounting: Factory, back mounted.
  - 10. Mounting: PregROUTED sheets of tiles factory assembled and grouted with manufacturer's standard white silicone rubber.
  - 11. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
    - a. External and Internal Corners: Bullnose/Corner shapes.
    - b. Base shapes: Cove Base/Corner Base.
    - c. Wainscoat Cap: 3" x 6" Bullnose cap.
    - d. External Corners for Thin-Set Mortar Installations: Surface bullnose, same size as adjoining flat tile.
    - e. Internal Corners: Field-buttet square corners. For coved base and cap use angle pieces designed to fit with stretcher shapes.

## **2.4 SETTING MATERIALS**

- A. Latex Portland Cement Mortar (Thinset): ANSI A118.4.
  - 1. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
  - 2. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
  - 3. For wall applications, provide mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
  - 4. Applications: TCA Installation Method W245 for wall tile, unless noted otherwise.



## **2.5 GROUT MATERIALS**

- A. Polymer-Modified Tile Grout: ANSI A118.7.
  - 1. Polymer Type: Either ethylene vinyl acetate or acrylic additive, in dry, redispersible form, prepackaged with other dry ingredients or Acrylic resin or styrene-butadiene rubber in liquid-latex form for addition to prepackaged dry-grout mix.
    - a. Unsanded grout mixture for joints 1/8 inch and narrower.

## **2.6 ELASTOMERIC SEALANTS**

- A. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Division 07 Section "Joint Sealants."
  - 1. Use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Use primers, backer rods, and sealant accessories recommended by sealant manufacturer.
- B. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.
- C. One-Part, Mildew-Resistant Silicone Sealant: Install in accordance with Division 07 Section "Joint Sealants" for wall joints.

## **2.7 MISCELLANEOUS MATERIALS**

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
- B. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

## **2.8 MIXING MORTARS AND GROUT**

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
  - 2. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.

3. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 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. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.

### **3.3 CERAMIC TILE INSTALLATION**

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
- B. 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.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Jointing Pattern: Lay tile in running bond pattern as indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
  2. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
- F. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
1. Glazed Wall Tile: CTW2: 1/16 inch.
- G. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- H. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.

### **3.4 ADJUSTING AND CLEANING**

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.

- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
  - 1. Remove grout residue from tile as soon as possible.
  - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

### **3.5 PROTECTION**

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

### **3.6 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE**

- A. Interior Wall Installations, Metal Studs or Furring:
  - 1. Ceramic Wall Tile Installation: TCNA W245 or TCNA W248; thinset mortar on glass-mat, water-resistant gypsum backer board.
    - a. Thinset Mortar: Latex-portland cement mortar.
    - b. Grout: Polymer-modified unsanded grout.

### **3.7 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling

**END OF SECTION 09 30 13**

## **SECTION 09 51 13 - ACOUSTICAL PANEL CEILINGS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes
  1. Acoustical panel ceilings.
  2. Exposed suspension systems for interior ceilings.
  3. Acoustical panel ceiling trim.
  4. Gypsum board ceiling trim.
- B. Related Requirements:
  1. Division 06 Section "Interior Architectural Woodwork" for wood panels installed with acoustical panel ceilings.
  2. Division 07 Section "Metal Composite Wall Panels" for additional exterior ceiling products.
  3. Division 09 Section "Gypsum Board" for GWB ceilings attached to ceilings in this Section with panel transitions.
- C. Products furnished, but not installed under this Section, include anchors, clips, and other ceiling attachment devices to be cast in concrete.

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
- B. Manufacturers installation specialist to attend Preinstallation Conference.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.
- C. Samples for Initial Selection: For components with factory-applied finishes.
- D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:
  1. Acoustical Panels: Set of 6-inch-square Samples of each type, color, pattern, and texture.
  2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch- long Samples of each type, finish, and color.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  1. Ceiling suspension-system members.
  2. Structural members to which suspension systems will be attached.
  3. Method of attaching hangers to building structure.
    - a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.

4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
5. Size and location of initial access modules for acoustical panels.
6. Items penetrating finished ceiling and ceiling-mounted items including the following:
  - a. Lighting fixtures.
  - b. Diffusers.
  - c. Grilles.
  - d. Speakers.
  - e. Sprinklers.
  - f. Access panels.
  - g. Perimeter moldings.
7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.
8. Minimum Drawing Scale: 1/8 inch = 1 foot for reflected ceiling plans; 1-1/2 inch per foot for details, including ceiling edges, transitions between ceiling types, and any other special details illustrated or indicated in the Drawings.

B. Qualification Data: For testing agency.

C. Product Test Reports: For each acoustical panel ceiling, for tests performed by a qualified testing agency.

D. Evaluation Reports: For each acoustical panel ceiling suspension system, from ICC-ES.

E. Field quality-control reports.

#### **1.6 CLOSEOUT SUBMITTALS**

A. Maintenance Data: For finishes to include in maintenance manuals.

#### **1.7 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
  2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.

#### **1.8 QUALITY ASSURANCE**

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
1. Build mockup of each ceiling type shown in the Drawings, in the following locations.
    - a. ACT 1 – Storage Room 126A.
    - b. ACT 2 – Info Literacy Classroom A, Room 101.
    - c. MP – Loading Dock.
    - d. AMP 1 – Group Study 232.
    - e. AMP 2 – Circulation 200B.
    - f. TZ 1 – Stacks 121.
    - g. TZ 2 – ITS Help Desk 403.
    - h. TZ 3 – ITS Help Desk 403.
    - i. WD 1 & 2 – Krame Center 126.
    - j. WD 3 & 4 – Conference 417.
  2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## **1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

## **1.10 FIELD CONDITIONS**

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
  - 1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

### **2.2 PERFORMANCE REQUIREMENTS**

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Flame-Spread Index: Class A according to ASTM E1264.
  - 2. Smoke-Developed Index: 50 or less.
- B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Indicate design designations from UL or from the listings of another qualified testing agency.

### **2.3 ACOUSTICAL PANELS**

- A. Basis of Design: Provide the following acoustical ceiling panels by Armstrong Ceiling and Wall Solutions, or approved equivalents.
- B. Acoustical Panel – ACT 1
  - 1. 'Calla' ceiling system, manufactured by Armstrong, or approved equivalent.
  - 2. Color: White.
  - 3. Edge/Joint Detail: 9/16" tegular edge; field cut edges to be tegular cut and finished with manufacturer's field applied touch up paint to match tile finish.
  - 4. Thickness: 7/8" inch.
  - 5. Modular Size: 24 by 24 inches.
  - 6. NRC: 0.85.
  - 7. 'Suprafine 9/16" exposed tee system.
  - 8. 2" Axiom perimeter trim at all ceiling edges not supported at wall
- C. Acoustical Panel – ACT 2
  - 1. 'Calla' ceiling system, manufactured by Armstrong, or approved equivalent.
  - 2. Color: White.

3. Edge/Joint Detail: 9/16" tegular edge; field cut edges to be tegular cut and finished with manufacturer's field applied touch up paint to match tile finish.
  4. Thickness: 7/8" inch.
  5. Modular Size: 24 by 48 inches.
  6. NRC: 0.85.
  7. 'Suprafine 9/16"' exposed tee system.
  8. 2" Axiom perimeter trim at all ceiling edges not supported at wall
- D. Ceiling Panel – MP 1
1. Alucobond Exterior Metal Panel System, or approved equivalent – see drawings.
  2. See Division 07 Section 'Metal Composite Wall Panels'
- E. Ceiling Panel – AMP 1
1. MetalWorks Torsion Spring Custom by Armstrong, or approved equivalent.
  2. 24" x 78" and 24" x 54" prefinished aluminum panels
  3. Exposed ceiling panels have 1 ½" upturned unperforated edge
  4. 6" wide Metalworks unperforated C-channel with 4" upturn, one side
  5. M15 perf pattern with acoustical fleece and 1" fiberglass infill panel; NRC=0.90
  6. Perimeter wires at floating ceiling edges (within 3' of edge) to be aircraft cable, 12 gage wire equivalent, not standard ceiling hanging wire
- F. Ceiling Panel – AMP 2
1. MetalWorks Torsion Spring Custom by Armstrong, or approved equivalent.
  2. 24" x 90" prefinished aluminum panels
  3. Exposed ceiling panels have 1 ½" upturned unperforated edge
  4. 6" wide Metalworks unperforated C-channel with 4" upturn, one side
  5. M15 perf pattern with acoustical fleece and 1" fiberglass infill panel; NRC=0.90
  6. Perimeter wires at floating ceiling edges (within 3' of edge) to be aircraft cable, 12 gage wire equivalent, not standard ceiling hanging wire
- G. Acoustical Panel – TZ 1
1. TechZone Ceiling Systems by Armstrong, or approved equivalent.
  2. 24" x 42" Optima Square Tegular Field ceiling panel with 6" 'Calla' Square Tegular Technical panel.
  3. 'Suprafine 9/16' exposed tee system; yoke located at continuous light fixtures.
  4. Perimeter wires at floating ceiling edges (within 3' of edge) to be aircraft cable, 12 gage wire equivalent, not standard ceiling hanging wire
  5. 2" Axiom perimeter trim at all ceiling edges not supported at wall
- H. Acoustical Panel – TZ 2
1. TechZone Ceiling Systems by Armstrong, or approved equivalent.
  2. 24" x 42" Prefinished Aluminum Square Tegular Field panel with 6"x4' Prefinished aluminum Square Tegular unperforated technical infill panel.
  3. M15 perf pattern with acoustical fleece and 1" fiberglass infill panel.
  4. 'Suprafine 9/16' exposed tee system; yoke located at continuous light fixtures.
  5. Perimeter wires at floating ceiling edges (within 3' of edge) to be aircraft cable, 12 gage wire equivalent, not standard ceiling hanging wire
  6. 2" Axiom perimeter trim at all ceiling edges not supported at wall
- I. Acoustical Panel – TZ 3
1. TechZone Ceiling Systems by Armstrong, or approved equivalent.
  2. 24" x 48" Prefinished Aluminum Square Tegular Field panel with 6"x4' Prefinished aluminum Square Tegular unperforated technical infill panel.
  3. M15 perf pattern with acoustical fleece and 1" fiberglass infill panel.
  4. 'Suprafine 9/16' exposed tee system; yoke located at continuous light fixtures.
  5. Perimeter wires at floating ceiling edges (within 3' of edge) to be aircraft cable, 12 gage wire equivalent, not standard ceiling hanging wire
  6. 2" Axiom perimeter trim at all ceiling edges not supported at wall

- J. Wood Plank – WD-1
  - 1. Woodworks Linear by Armstrong, or approved equivalent.
  - 2. Wood Plank: Nominal 3" wide.
  - 3. Panel Size: See drawings; 12" x 96" Typical
  - 4. Finish: Grille White.
  - 5. Acoustical Infill Panel: BioAcoustic Infill Panel to achieve NRC of 0.75.
    - a. Size to match ceiling panels
    - b. Finish: Black Matte.
  - 6. Suspension System: 15/16" Prelude XL, Black.
  - 7. Provide 4" high wood ceiling trim to match; see Drawings.
  
- K. Wood Panel – WD-2
  - 1. See Division 06 Section "Interior Architectural Woodwork" for custom wood panel to match Armstrong ceiling.
  - 2. Panel Size: 12" wide.
  - 3. Finish: White to match WD-1.
  - 4. Suspension System: 15/16" Prelude XL, Black.
  - 5. Provide 4" high wood ceiling trim to match; see Drawings
  
- L. Wood Grille – WD-3
  - 1. Woodworks Grille by Armstrong, or approved equivalent.
  - 2. Wood Slats: 5/8" wide x 1-3/8" high.
  - 3. Slat Spacing: 7/8".
  - 4. Panel Size: See drawings; 12" x 96" Typical
  - 5. Installation Type: Backer.
  - 6. Finish: Grille Maple.
  - 7. Acoustical Infill Panel: BioAcoustic Infill Panel to achieve NRC of 0.75.
    - a. Size to match ceiling panels
    - b. Finish: Black Matte.
  - 8. Suspension System: Heavy Duty 15/16" Prelude XL, Black.
  - 9. Provide aluminum and wood Angle Molding with Ledger Piece to match; see Drawings.
  
- M. Wood Panel – WD-4
  - 1. See Division 06 Section "Interior Architectural Woodwork" for custom wood panel to match maple veneer millwork in same room.
  - 2. Panel Size: 12" wide.
  - 3. Finish: Clear finish maple to match millwork
  - 4. Suspension System: Heavy Duty 15/16" Prelude XL, Black.
  - 5. Provide aluminum and wood Angle Molding with Ledger Piece to match; see Drawings

## 2.4 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
  
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
  - 1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
  - 2. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.135-inch- diameter wire.
  - 3. Stainless Steel Aircraft Cable for exposed edges of ceiling:
    - a. Provide aircraft cable of equivalent strength as zinc-coated steel wire for exposed ceiling cloud edges.
    - b. Do not paint aircraft cable.
  
- C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
  
- D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.



- E. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch-thick, galvanized-steel sheet complying with ASTM A653/A653M, G90 coating designation; with bolted connections and 5/16-inch-diameter bolts.
- F. Hold-Down Clips: Manufacturer's standard hold-down.

## **2.5 METAL EDGE MOLDINGS AND TRIM, GENERAL**

- A. Roll-Formed, Sheet-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.
  - 1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
  - 2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
  - 3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.
- B. Provide manufacturer's Acoustical and Drywall Transition Molding at every transition between acoustical panel ceilings and gypsum board ceilings when they occur at the same elevation. See Drawings for typical application.
  - 1. Includes knurled and slotted integral taping flange to accommodate taping and finishing.

## **2.6 EXTRUDED ALUMINUM EDGE MOULDINGS AND TRIM**

- A. Where indicated on drawings and also where listed below, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements.
  - 1. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils. Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
  - 2. Color: As selected by the Architect from the manufacturer's full range of standard and custom colors.
- B. Basis-of-Design: Axiom Classic Trim by Armstrong Ceiling and Wall Systems, or approved equivalent.
  - 1. 3/4" x 1-15/16" high, to be installed at 2'x2' and 2'x4' suspended ceiling edges of 'floating ceilings' and at locations where ceiling does not extend to face of wall, unless noted or detailed otherwise.
    - a. Cut back corner of suspension system, when exposed above trim.
  - 2. 2 -1/2" Drywall Trim with spackle edge; see Drawings for locations.
    - a. Prefinished white.
  - 3. Provide factory mitered corners for Axiom Trim.

## **2.7 ACOUSTICAL SEALANT**

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - 1. Acoustical Sealant for Exposed and Concealed Joints:
    - a. Pecora Corporation; AC-20 FTR Acoustical and Insulation Sealant.
    - b. USG Corporation; SHEETROCK Acoustical Sealant.
    - c. Or approved equivalent.
  - 2. Acoustical Sealant for Concealed Joints:
    - a. Henkel Corporation; OSI Pro-Series SC-175 Acoustical Sound Sealant.
    - b. Pecora Corporation; AIS-919.

- c. Tremco, Inc.; Tremco Acoustical Sealant.
  - d. Or approved equivalent.
- B. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
- 1. Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant.
  - 2. Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant.
  - 3. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. 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 unless otherwise indicated, and comply with layout shown on reflected ceiling plans.
- B. Layout openings for penetrations centered on the penetrating items.

### **3.3 INSTALLATION**

- A. Install acoustical panel ceilings according to ASTM C636/C636M and manufacturer's written instructions.
- B. Suspend ceiling hangers from building's structural members and as follows:
  - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
  - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
  - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
  - 4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
  - 5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.

6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
  7. 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.
  8. Do not attach hangers to steel deck tabs.
  9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
  10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
  11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
  12. Install stainless steel aircraft cable hangers instead of standard wire hangers when within 3 feet of an exposed ceiling edge.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
  2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends. Miter corners accurately and connect securely.
  3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- 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 precise fit.
1. Arrange directionally patterned acoustical panels as follows:
    - a. As indicated on reflected ceiling plans.
  2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
  3. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
  4. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
  5. Re-regular all cut edges of tegular ceiling tiles.
  6. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
  7. Install hold-down clips in areas indicated; space according to panel manufacturer's written instructions unless otherwise indicated.

### **3.4 ERECTION TOLERANCES**

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.
- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

### **3.5 CLEANING**

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

### **3.6 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 09 51 13**

## **SECTION 09 62 29 - CORK FLOORING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Solid cork flooring.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of cork flooring.
  - 1. Include cork flooring layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
- C. Samples: Full-size units of each type, color, pattern, and finish of cork flooring required.
- D. Samples for Initial Selection: Submit representative selection of samples for finish, color and shade.
- E. Samples for Verification: Full-size units of each type, color, pattern, and finish of cork flooring required.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For each type of cork flooring to include in maintenance manuals.

#### **1.5 QUALITY ASSURANCE**

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  - 1. Coordinate mockups in this Section with mockups specified in other Sections.
    - a. Install cork flooring in Room 126A to serve as mockup. Match size and color of cork to be installed in Room 126.
    - b. Simulate finished lighting conditions for review of mockups.
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- B. Documents. Submit the following:
  - 1. Test reports showing compliance with specified performance and physical characteristics
  - 2. Installation and Maintenance instructions.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store cork flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F. Store cork flooring on flat surfaces.

## 1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 65 deg F or more than 85 deg F where relative humidity is between 45 and 55 percent, in spaces to receive cork flooring during the following periods:
  - 1. 72 hours before installation.
  - 2. During installation.
  - 3. 72 hours after installation.
- B. Close spaces to traffic during cork flooring installation.
- C. Close spaces to traffic for 72 hours after cork flooring installation.
- D. Install cork flooring after other finishing operations, including painting and installation of ceiling systems, have been completed.

## PART 2 - PRODUCTS

### 2.1 CORK FLOOR TILE

- A. Basis of Design: Praxis Solid Cork Tile, by Zandur, or approved equivalent.
- B. Resilient Cork Tile Flooring with the following physical characteristics:
  - 1. Manufactured with a composition of 96% cork and 4% non-phenolic urethane resin.
  - 2. Manufactured with water-based binders, pigments and finishes.
  - 3. Product is aged for a minimum of 4 weeks prior to final processing to ensure dimensional stability.
  - 4. Overall thickness (Specify):
    - a. 3/16" (4.8mm)
  - 5. Finishes (Specify):
    - a. 7 Coats Commercial Grade Water Based Matte Polyurethane
  - 6. Tile size (Specify):
    - a. 11.8" x 35.4" – Install in Special Collections Reading Room 215
    - b. 5.9" x 35.4" – Install in Krame Center 126, Storage 126A and Open Study 123B
  - 7. Pattern (Specify): CT1001.
    - a. ASTM D 3389 Standard Test Method for Coated Fabrics Abrasion Resistance: < 1.00-gram weight loss.
    - b. ASTM D 2047, Standard Test Method for Static Coefficient of Friction of Polish-Coated Flooring: Exceeds Federal Standards and A.D.A. requirements for slip-resistance.
    - c. ASTM F 970, Standard Test Method for Static Load Limit – passes.
    - d. ASTM E 648, Standard Test method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source – Class II
    - e. Meets California Section 01350 indoor air quality test
    - f. Phthalate, chlorine and halogen-free.
    - g. Meets requirements for LEED MR4.1, MR4.2, MR 6.0 and IEQ4.3.

### 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 cork flooring manufacturer for applications indicated.

- B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit cork flooring and substrate conditions indicated.
  - a. Zandur #40 Water Based Contact Adhesive, or approved equivalent.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
  - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of cork flooring.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Prepare substrates according to cork flooring manufacturer's written instructions to ensure adhesion of cork flooring.
- B. General Information & Requirements for All Sub-Floors
  - 1. Material must be installed on a subfloor that is permanently dry, clean, smooth and structurally sound. The sub-floor must be free of contaminants such as paint, oil, wax, mold, adhesive residues, sealers or any other materials that may interfere with adhesive bonding. See current instructions for approved cementitious sub-floors. **DO NOT INSTALL MATERIAL OVER EXISTING FLOOR COVERINGS OR ADHESIVE RESIDUE.**
  - 2. Prior to installation an adhesive bond test must be performed by gluing a tile to the sub-floor. Allow adhesive to cure overnight. If bond is sufficient, tile will be laying flat and it will not be possible to remove tile by hand.
  - 3. All Sub-floors shall be flat to within 3/16" in 10' and shall be patched or skim coated with a hard setting underlayment compound to ensure substrate is completely smooth with a minimum compressive strength of 3,000 psi. Do not apply patching material over existing adhesives. Manufacturer is not responsible for any claims submitted on floors where patching materials have been applied over adhesive residue or over existing floor coverings regardless of manufacturer instructions. After patching or skimming is complete, floor must be sanded or scraped to remove any trowel marks or other inconsistencies which may telegraph through the finished flooring material. Follow manufacturers guidelines for product mixing and use instructions.
- C. Preparation of Concrete Sub-Floors
  - 1. Concrete sub-floors shall be prepared in accordance with ASTM F 710 Standard practice for preparing concrete sub-floors to receive resilient flooring. Concrete sub-floors must be clean as specified. Pay specific attention to possible presence of a sealer which must be removed. It is highly recommended to shot blast or bead blast existing concrete sub-floors prior to installation to remove sealers, adhesives and/or any other surface contaminants.
  - 2. Concrete sub-floors on or below grade must have a moisture retarder and all concrete subfloors, regardless of age, must be tested for the moisture vapor emission rate and relative humidity to ensure the sub-floor is suitable for floor covering installation.
  - 3. Testing of concrete shall be performed **ONLY** when the building is enclosed and when the HVAC system has been in operation for at least 7 days. Furthermore, job-site temperature and humidity must be at the level expected during normal use or in the range of 65°F to 85°F and 45% to 55% relative humidity.
  - 4. Moisture tests must be performed according to manufacturer's instruction and meet manufacturers current published sub-floor moisture requirements. Testing shall occur at a rate of 3 tests for the first 1,000 square feet and then 1 additional test per additional 1,000 square feet.

5. Sub-Floor pH must be tested with wide range pH paper and verified to be no greater than 9. Test as per ASTM F-710.
  6. Level sub-floor as specified
  7. Allow patching materials to dry naturally without the use of direct air or temporary HVAC.
- D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
  - E. Do not install cork flooring until materials are the same temperature as space where they are to be installed.
    1. At least 72 hours in advance of installation, move cork flooring products and installation materials into spaces where they will be installed.
  - F. Immediately before installation, sweep and vacuum clean substrates to be covered by cork flooring.

### **3.3 FLOOR TILE INSTALLATION**

- A. Comply with manufacturer's written instructions for installing resilient Solid Cork tile flooring.
- B. Mix together floor tiles from each carton to ensure uniform distribution of shade.
- C. Discard broken, cracked, chipped, or deformed floor tiles.
- D. 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.
- E. Lay floor tiles square with room in direction and pattern directed by Architect.
- F. 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.
- G. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- H. 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 marking device.
- I. Install with Zandur manufacturers recommended contact adhesive which is applied to the tile back and to the sub-floor using a 3/8" nap roller. Follow up to date instructions for proper use.
- J. After setting tiles, secure in place using a soft rubber mallet.

### **3.4 CLEANING AND PROTECTION**

- A. Comply with manufacturer's written instructions for cleaning and protecting cork flooring.
- B. Perform the following operations immediately after completing cork flooring installation:
  1. Remove adhesive and other blemishes from surfaces.
  2. Sweep and vacuum surfaces thoroughly.
  3. Damp-mop surfaces to remove marks and soil.
- C. Protect cork flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.



- D. Limit traffic for 24 hours after installation.
- E. No heavy traffic, rolling loads, or furniture placement for 72 hours after installation.
- F. Wait 72 hours after installation before performing initial cleaning.
- G. A regular maintenance program must commence after the initial cleaning.
- H. Cover cork flooring until Substantial Completion.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 09 62 29**

## **SECTION 09 65 13 - RESILIENT BASE AND ACCESSORIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Thermoset-rubber base.
  - 2. Rubber molding accessories.
- B. Related Sections:
  - 1. Division 09 Section "Linoleum Flooring" for linoleum floor coverings.
  - 2. Division 09 Section "Carpet Tile" for carpet tile flooring.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.
- C. Samples for Initial Selection: For each type of product indicated.
- D. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.
- E. Product Schedule: For resilient base and accessory products.

#### **1.4 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

#### **1.5 QUALITY ASSURANCE**

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  - 1. Coordinate mockups in this Section with mockups specified in other Sections.
  - 2. Install resilient base in Service Corridor 100C to serve as mockup.
  - 3. Simulate finished lighting conditions for review of mockups.
- B. 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.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

## **1.7 FIELD CONDITIONS**

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following periods:
  - 1. 48 hours before installation.
  - 2. During installation.
  - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

## **1.8 WARRANTY**

- A. Rubber Base Warranty: Written warranty, signed by manufacturer agreeing to repair or replace rubber base that fails in materials or workmanship. Failures include, but are not limited to, excessive wear, buckling, cupping, warping, splitting, cracking and delamination.
  - 1. Contractor shall install rubber base with manufacturer's recommended adhesives and installation techniques as is required for a three year warranty.

## **PART 2 - PRODUCTS**

### **2.1 THERMOSET-RUBBER BASE**

- A. Basis of Design Product: Subject to compliance with requirements, provide "Pinnacle Rubber Base: No Toe" as manufactured by Roppe or approved equivalent.
- B. Product Standard: ASTM F1861, Type TS (rubber, vulcanized thermoset), Group I (solid, homogeneous).
  - 1. Style and Location:
    - a. Style A, Straight: Provide in areas with carpet or terrazzo.
    - b. Style B, Cove: Provide in areas with resilient floor coverings.
- C. Thickness: 0.125 inch.
- D. Height: 2-1/2 inches.
- E. Lengths: Coils in manufacturer's standard length.
- F. Outside Corners: Preformed.
- G. Inside Corners: Job formed or preformed.
- H. Colors: As selected by Architect from full range of industry colors.
- I. Number of Colors: Three.

## **2.2 RUBBER MOLDING ACCESSORY**

- A. Basis of Design Product: Subject to compliance with requirements, provide products manufactured by Roppe or approved equivalent.
- B. Description: Rubber transition strips.
- C. Profile, Dimensions and Locations: As indicated in drawings or as required for each transition between different flooring materials and conditions.
- D. Colors and Patterns: As selected by Architect from full range of industry colors.
- E. Number of Colors: Three, to coordinate with adjacent floor finishes.

## **2.3 INSTALLATION MATERIALS**

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.
  - 1. Adhesives shall have a VOC content of 50 g/L or less.
- C. Metal Edge Strips: Extruded aluminum with mill finish of width shown, of height required to protect exposed edges of flooring, and in maximum available lengths to minimize running joints.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
  - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 1. Installation of resilient products indicates acceptance of surfaces and conditions.

### **3.2 PREPARATION**

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- C. Do not install resilient products until materials are the same temperature as space where they are to be installed.
  - 1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- D. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

### **3.3 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 practical 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.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.
- H. Job-Formed Corners:
  - 1. Inside Corners: Use straight pieces of maximum lengths possible. Form without producing discoloration (whitening) at the bends.

### **3.4 RESILIENT ACCESSORY INSTALLATION**

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

### **3.5 CLEANING AND PROTECTION**

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
  - 1. Remove adhesive and other blemishes from surfaces.
  - 2. Sweep and vacuum horizontal surfaces thoroughly.
  - 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

### **3.6 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.

- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 09 65 13**

## **SECTION 09 65 43 - LINOLEUM FLOORING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Linoleum sheet flooring.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of linoleum flooring.
  - 1. Include flooring layouts, locations of seams, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
  - 2. Show details of special patterns.
- C. Samples: For each exposed product and for each color and pattern specified in manufacturer's standard size, but not less than 6-by-9-inch sections.
- D. Samples for Initial Selection: For each type of linoleum flooring indicated.
- E. Samples for Verification: For each type of linoleum flooring, in manufacturer's standard size, but not less than 6-by-9-inch sections.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For each type of linoleum flooring to include in maintenance manuals.

#### **1.6 QUALITY ASSURANCE**

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for flooring installation and seaming methods indicated.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  - 1. Coordinate mockups in this Section with mockups specified in other Sections.
  - 2. Install linoleum flooring in Service Corridor 100C as a mockup.
  - 3. Simulate finished lighting conditions for review of mockups.

#### **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Store flooring and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 65 deg F or more than 90 deg F.
  - 1. Sheet Flooring: Store rolls upright.

## 1.8 FIELD CONDITIONS

- A. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F (13 deg C) or more than 95 deg F (35 deg C).
- B. Close spaces to traffic during flooring installation.
- C. Close spaces to traffic for 72 hours after flooring installation.
- D. Install flooring after other finishing operations, including painting, have been completed.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For linoleum flooring, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
  - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

### 2.2 LINOLEUM SHEET FLOORING

- A. Provide the following product or approved equivalent:
  - 1. Marmoleum Dual by Forbo Industries, Inc.
- B. Linoleum Sheet Flooring: ASTM F 2034, Type I, linoleum sheet with backing.
  - 1. Roll Size: In manufacturer's standard length but not less than 78 inches (1980 mm) wide.
- C. Thickness: 0.10 inch (2.5 mm).
- D. Colors and Patterns: As selected by Architect from full range of manufacturer's standard and premium colors.
- E. Slip Resistance: 0.6 per ASTM D2047.
- F. Castor Resistance: EN 425: Suitable for office chairs with castors.

### 2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland-cement-based or blended hydraulic-cement-based formulation provided or approved by linoleum flooring manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by flooring and adhesive manufacturers to suit products and substrate conditions indicated.
  - 1. Adhesives shall have a VOC content of 50 g/L or less.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
  - 1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of flooring.



- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Prepare substrates according to linoleum flooring manufacturer's written instructions to ensure adhesion of flooring.
- B. Concrete Substrates: Prepare according to ASTM F710.
  - 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 flooring adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by linoleum flooring manufacturer. Do not use solvents.
  - 3. Alkalinity and Adhesion Testing: Perform tests recommended by linoleum flooring manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing.
  - 4. Moisture Testing: Perform tests recommended by linoleum flooring manufacturer, but not less stringent than the following:
    - a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. (1.36 kg of water/92.9 sq. m) in 24 hours.
    - b. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have maximum 75 percent relative humidity level.
- C. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.
- D. Do not install flooring until materials are the same temperature as space where they are to be installed.
  - 1. At least 72 hours in advance of installation, move flooring and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by flooring.

### **3.3 INSTALLATION, GENERAL**

- A. Comply with manufacturer's written instructions for installing flooring.
- B. Scribe and cut flooring to butt neatly and tightly to vertical surfaces and permanent fixtures, including built-in furniture, cabinets, pipes, outlets, edgings, thresholds, door frames, and nosings.
- C. Extend flooring into toe spaces, door reveals, closets, and similar openings.
- D. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on flooring as marked on substrates. Use chalk or other nonpermanent marking device.
- E. Install flooring on covers for telephone and electrical ducts and similar items in installation areas. Maintain overall continuity of color and pattern between pieces of flooring installed on covers and adjoining flooring. Tightly adhere flooring edges to substrates that abut covers and to cover perimeters.
- F. Adhere flooring to 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.

### **3.4 LINOLEUM SHEET FLOORING INSTALLATION**

- A. Unroll linoleum sheet flooring and allow it to stabilize before cutting and fitting.
- B. Lay out linoleum sheet flooring as follows:
  - 1. Maintain uniformity of flooring direction.
  - 2. Minimize number of seams; place seams in inconspicuous and low-traffic areas, at least 6 inches away from parallel joints in flooring substrates.
  - 3. Match edges of flooring for color shading at seams.
  - 4. Avoid cross seams.
  - 5. Eliminate deformations that result from hanging method used during drying process (stove bar marks).

### **3.5 CLEANING AND PROTECTION**

- A. Comply with manufacturer's written instructions for cleaning and protecting linoleum flooring.
- B. Perform the following operations immediately after completing linoleum flooring installation:
  - 1. Remove adhesive and other blemishes from surfaces.
  - 2. Sweep and vacuum surfaces thoroughly.
  - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect linoleum flooring from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. After allowing drying room film (yellow film caused by linseed oil oxidation) to disappear, cover linoleum flooring until Substantial Completion.

### **3.6 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged during construction.
  - 1. Separate tempered glass waste for use as aggregate of nonstructural fill
- C. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling

**END OF SECTION 09 65 43**

## **SECTION 09 66 23 - RESINOUS MATRIX TERRAZZO FLOORING**

### **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. Section Includes:
  - 1. Thin-set epoxy terrazzo flooring including preparation of substrates.
  - 2. Related accessories.
- B. Related Sections:
  - 1. Division 03 Section "Cast In Place Concrete."
  - 2. Division 07 Section "Joint Sealants."

#### **1.3 SUBMITTALS**

- A. Manufacturer's product data for each type of terrazzo and accessory. System will be evaluated on the basis of standards. For tests not listed in published data, manufacturer shall supply missing data according to standard referenced
  - 1. Physical properties.
  - 2. Performance properties.
  - 3. Specified tests.
  - 4. Material Safety Data Sheet.
  - 5. Manufacturer's standard warranty.
- B. Shop Drawings. Include terrazzo installation requirements. Include plans, elevations, sections, component details and attachments to other work. Show layout of the following:
  - 1. Divider strips.
  - 2. Control and expansion joint strips.
  - 3. Base and border strips.
  - 4. Abrasive strips.
  - 5. Terrazzo patterns.
- C. Samples for initial selection from manufacturers color plates showing the full range of colors and patterns available for each terrazzo type indicated.
- D. Samples for Verification: Match architect's samples for each type, material, color and pattern of terrazzo and accessory required showing the full range of color, texture and pattern variations expected. Label each terrazzo sample to identify matrix color and aggregate types, sizes and proportions. Prepare samples of same thickness and from same material to be used for the work in size indicated below:
  - 1. Epoxy terrazzo: minimum 6" x 6" (152.4 mm x 152.4 mm) sample of each color and type of terrazzo.
  - 2. Accessories: 6" length (152.4 mm) of each kind of divider strip, stop strip and control joint strip required.
- E. Manufacturer Experience:
  - 1. Submit proof of associate membership in NTMA.
  - 2. Furnish a list of at least five (5) epoxy terrazzo projects using material being submitted for this project installed during the last five (5) years of the same scope, complexity and square footage.

- F. Qualification Data: For qualified installer.
  - 1. Submit proof of contractor membership in NTMA.
  - 2. Furnish a list of at least five (5) epoxy terrazzo projects using material being submitted for this project installed during the last five (5) years of the same scope, complexity and square footage.
- G. Material Test Reports: For moisture and/or relative humidity of substrate.
- H. Maintenance Data: Submit digital copy of NTMA maintenance recommendations manufacturer's instructions

#### **1.4 QUALITY ASSURANCE**

- A. Installer Qualifications: A qualified installer who is acceptable to architect and epoxy terrazzo manufacturer to install manufacturer's products.
  - 1. Engage a terrazzo contractor with at least ten (10) years of satisfactory experience in installation of epoxy terrazzo. Terrazzo contractor shall demonstrate experience during last five (5) years of at least five (5) projects of comparable scope, complexity and square footage of this project.
  - 2. Engage an installer who is a contractor member of NTMA.
- B. Source Limitations:
  - 1. Engage an epoxy manufacturer with at least ten (10) years of satisfactory experience manufacturing epoxy terrazzo, moisture treatment system and crack isolation membrane.
  - 2. Obtain primary Epoxy Terrazzo Flooring System materials including moisture treatment, membranes, primers, resins and hardening agents from a single manufacturer with proof of NTMA membership.
  - 3. Obtain aggregates, divider strips, sealers and cleaners from source recommended by primary materials manufacturer.
- C. Pre-installation Conference: Conduct conference at project site. Review methods and procedure related to terrazzo including, but not limited to, the following:
  - 1. Inspect and discuss installation procedures, joint details, job site conditions, substrate specification, vapor barrier details and coordination with other trades.
  - 2. Review and finalize construction schedule and verify availability of materials, installer's personnel, equipment and facilities needed to make progress and avoid delays.
  - 3. Review special terrazzo designs and patterns.
  - 4. Review plans for concrete curing and site drying to enable timely achievement of suitable slab moisture conditions.
- D. 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.
- E. Mock-ups: Build mock-ups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  - 1. Build mock-ups for terrazzo including accessories.
    - a. Install flooring in Level 1 Core (Elevator Vestibule 100B & Rooms 102-106.)
    - b. Install example of each type of joint and strip material to be used on the project in Janitor Closet Room 102 as part of this mockup.
  - 2. Approved mockups may become part of the completed work if undisturbed at time of substantial completion.

#### **1.5 DELIVERY, STORAGE AND HANDLING**

- A. Deliver materials to project site in supplier's original wrappings and containers labeled with source's or manufacturer's name, material or product brand name and lot number if any.

- B. Store materials in their original, undamaged packages and containers inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures and humidity.
  - 1. Storage temperatures should be between 50°F to 80°F (10.0°C to 26.6°C).

## 1.6 PROJECT CONDITIONS

- A. Prior to surface preparation, terrazzo contractor shall:
  - 1. Evaluate slab condition, including slab moisture content and extent of repairs required, if any.
  - 2. Maintain the ambient room and floor temperature at 60°F (15.5°C) or above for a period extending 72 hours before, during and after floor installation. Concrete to receive epoxy terrazzo shall have cured for at least 28 days and be free of all curing compounds. Test concrete substrate to determine acceptable moisture levels prior to installation. Testing should be conducted according to ASTM F2170 (determining relative humidity in concrete slabs using in situ probes). Proceed with installation only after substrates have a maximum relative humidity measurement reading less than 80%. If relative humidity measurement reading is greater than or equal to 80%, manufacturer's Moisture Vapor Treatment is required. Apply to terrazzo substrates according to manufacturer's instructions.
- B. Prior to and during each day of installation, the terrazzo contractor shall verify that the dew point is at least 5°F (-15°C) less than the slab and air temperature.
- C. Acceptable Substrates:
  - 1. Level tolerance: Concrete sub-floor shall be level with a maximum variation from level of 1/4" in 10 feet (6.4 mm in 3.1m). Any irregularity of the surface requiring patching and/or leveling shall be done using epoxy and sand fill as recommended by manufacturer.
  - 2. Concrete floor shall be prepared mechanically by shot blasting in accordance with ICRI Guideline No. 03732. Specifically, surface preparation results should achieve a CSP3-CSP5 profile.
  - 3. Concrete floor shall receive a steel trowel finish.
  - 4. Concrete shall be cured a minimum of 28 days. No curing agents are to be used in areas to receive terrazzo.
  - 5. Concrete slab shall have an efficient moisture vapor barrier (suggested minimum: 15 mils (.4 mm thickness)) directly under the concrete slab. Moisture barrier shall NOT be punctured.
  - 6. Saw cutting of control joints must be done between 12 and 24 hours after placement of the structural concrete and at a frequency compatible to ACI recommendations.
- D. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during terrazzo installation.
- E. Close spaces to traffic during terrazzo application and for not less than 24 hours after application unless manufacturer recommends a longer period.
- F. Provide protection from other trades prior to final acceptance by owner.

## PART 2 -- PRODUCTS

### 2.1 EPOXY TERRAZZO

- A. Products: Systems Overview: The basis of design is Terroxy® Resin Systems Epoxy Matrix by Terrazzo & Marble Supply Companies, or approved equivalent.
- B. Materials:
  - 1. Primer: Primer
  - 2. Moisture Vapor Treatment: Moisture Vapor Treatment (MVT).

- a. Contractor to include MVT for all slabs on-grade, light weight concrete and green concrete. MVT System must handle up to 95% R.H. in accordance with MVT Testing.
- b. Physical properties of moisture mitigating primer shall have a maximum of 0.3 perms with 100% RH.
3. Flexible Reinforcing Membrane: Iso-Crack Epoxy Membrane, for substrate crack preparation and reflective crack reduction.
  - a. Reinforcement: fiberglass scrim (optional).
4. Epoxy Matrix: Epoxy Matrix and in color required for mix indicated.
  - a. Physical properties without aggregates. All specimens cured for 7 days at 73-77°F (22.8-25°C) and 50 percent plus or minus 2 percent RH. This product shall meet the following requirements:
    - 1) Hardness: ASTM D—2240 using Shore-D Durometer
      - a) NTMA requirement: 60-85
      - b) Terroxy typical result: 75-85
    - 2) Tensile Strength: ASTM D-638
      - a) NTMA requirement: 3,000 psi min.
      - b) Terroxy typical result: 4,800 psi min.
    - 3) Compressive Strength: ASTM-D695 Specimen B Cylinder
      - a) NTMA Requirement: 10,000 psi min., 69.9 MPa
      - b) Terroxy Typical result: 12,000 psi min., 31.7 MPa
    - 4) Flexural Strength: ASTM D-790
      - a) NTMA Requirement: Not specified
      - b) Terroxy Typical result: 4,500 psi min., 31.7 MPa
    - 5) Chemical Resistance: ASTM D-1308, seven days at room temperature by immersion method
      - a) NTMA requirement: No deleterious effects: distilled water, mineral oil, isopropanol, ethanol, 0.025 detergent solution, 1% soap solution, 10% sodium hydroxide, 10% hydrochloric acid, 30% sulfuric acid, 5% acetic acid
      - b) Terroxy typical result: No deleterious effects: distilled water, mineral oil, isopropanol, ethanol, 0.025 detergent solution, 1% soap solution, 10% sodium hydroxide, 10% hydrochloric acid, 30% sulfuric acid, 5% acetic acid
  - b. Physical properties with aggregates. For Epoxy Matrix blended with three volumes of Valdres marble blended 60% #1 chip and 40% #0 chip, ground and grouted with epoxy resin according to Installation Specifications, finishing to a nominal 3/8" (9.5 mm) thickness. All specimens cured for 7 days at 73-77°F (22.8-25°C) and 50 percent RH plus or minus 2 percent RH. This finished Epoxy Matrix shall meet the following requirements:
    - 1) Flammability: ASTM D-635
      - a) NTMA Requirement: Self-extinguishing, extent of burning 0.25 inches max.
      - b) Terroxy typical result: Self extinguishing, extent of burning 0.25 inches max.
    - 2) Thermal Coefficient of Linear Expansion: ASTM D-696
      - a) NTMA Requirement: 25x10<sup>-6</sup> inches per inch per degrees to 140°F, 11.4 x 10<sup>-7</sup> cm per cm per °C to 60°C Max
      - b) Terroxy typical result: 25x10<sup>-6</sup> inches per inch per degrees to 140°F, 11.4 x 10<sup>-7</sup> cm per cm per °C to 60°C Max
    - 3) Bond Strength: ACI COMM 403, Bulletin 59-43 (pages 1139-1141)
      - a) NTMA Requirement: 300 psi (100% concrete failure), 2.1 MPa (100% concrete failure)
      - b) Terroxy typical result: 300 psi (100% concrete failure), 2.1 MPa (100% concrete failure)
5. Aggregates: Marble; 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 0.74 percent.
  - c. Dust Content: Less than 1.0 percent by weight.
  - 6. Finishing Grout: Epoxy Matrix or Clear Resin with a broadcast of limestone filler as recommended by manufacturer.
- C. Mix: Comply with NTMA's "Terrazzo Specifications and Design Guide" and manufacturer's written instructions for matrix and aggregate proportions and mixing.
- 1. Color and pattern schedule: Where the following designations are indicated, provide specified terrazzo matrices matching architect's samples:
    - a. TRZ1: TM# 19-139 (field color)
    - b. TRZ2: TM# 19-134 (bluestone color)

## 2.2 STRIP MATERIALS

- A. Thin-set Divider Strips: L-type.
- 1. Material: White-zinc alloy.
  - 2. Depth: 3/8"
  - 3. Top width: 1/16"
  - 4. Guide for commonly used L-type divider strips for Thin-set Epoxy Terrazzo Systems
- B. Control/Construction Joints (saw cut, cold joint): Detail joints in accordance with NTMA Tech Bulletin T-24.
- 1. Option 1. Preferred: Separate double L-type angles back to back with minimum 1/8" (3.2mm) width between. Fill joint and area between strips with semi-flexible joint filler.
  - 2. Option 2. Fill saw cut with 100% solids epoxy. Place single L-type angle strip shouldered on concrete, adjacent to the joint.
  - 3. Option 3. Buried Joint: Fill saw cut with 100% solids epoxy, followed by application of Iso-Crack Membrane (40 mils / 1.0 mm) with fiberglass mesh reinforcement embedded into the membrane. Note: Movement from the substrate may reflect through the finished floor.
- C. Expansion Joint Strips: Separate double L-type angles, positioned back to back with minimum 1/8" (3.2 mm) width between. Fill area between strips with semi-flexible joint filler.
- D. Random Crack Detail: For cracks over 1/16" width before surface preparation.
- 1. Fill saw cut with 100% solids epoxy, followed by application of Iso-Crack Membrane (40 mils / 1.0mm) with fiberglass mesh reinforcement embedded into the membrane.
    - a. Contractor to include 10% lineal ft for random crack repair
  - 2. Note: Movement from the substrate may reflect through the finished flooring.
- E. Special Considerations: For epoxy terrazzo exposed to direct sunlight use strip method B Option 1 (referenced above) every 8'-12' in each direction to compensate for thermal expansion/contraction.

## 2.3 MISCELLANEOUS ACCESSORIES

- A. Strip Adhesive: 100% solids epoxy resin adhesive recommended by manufacturer.
- 1. Use adhesive that has a VOC content of 50g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Anchoring Devices:
- 1. Strips: Provide mechanical anchoring devices for strip materials as required for secure attachment to substrate.
- C. Patching and Fill Material: epoxy and sand fill as recommended by manufacturer.
- D. Joint Compound: Joint Filler, color to be selected by architect to match/compliment terrazzo.

- E. Cleaner: Terra Clean, a neutral cleaner with pH factor between 7 and 10 specifically designed for terrazzo.
- F. Surface Finish System: All terrazzo shall be finished to a minimum 200 Grit finish, with the exception of black terrazzo, which will be finished up to a 400 Grit Finish.
- G. Sealer: Slip and stain-resistant sealer that is chemically neutral with a pH factor between 7 and 10, that meets a standard coefficient of friction of 0.6 or higher, as measured by the James Machine (ASTM D-2047 Test Method), does not affect physical properties of terrazzo and complies with NTMA's "Terrazzo Specifications and Design Guide."

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and areas, with Terrazzo Contractor present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions, including level tolerances, have been corrected.

### **3.2 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 surface free of laitance, glaze, efflorescence, curing compounds, form-release agents, dust, dirt, grease, oil and other contaminants incompatible with terrazzo.
    - a. Prepare concrete mechanically by shot blasting. Surface preparation results should achieve a CSP3-CSP5 profile according to International Concrete Repair Institute Guideline No. 03732.
    - b. Repair or level damaged and deteriorated concrete according to Terroxy® Resin Systems Technical Bulletin 008 Substrate Leveling Requirements for thin-set epoxy terrazzo
    - c. Repair cracks and non-expansion joints greater than 1/16" (1.6 mm) wide according to Terroxy® Resin Systems Technical Bulletin 009 Crack Detailing and Joint Treatments for Thin-set epoxy terrazzo.
  - 2. Verify that concrete substrates are visibly dry and free of moisture.
  - 3. Moisture Testing:
    - a. Test for moisture according to ASTM F2170 (determining relative humidity in concrete slabs using in situ probes).
    - b. Proceed with installation only after substrates have a maximum relative humidity measurement reading less than 80%. If relative humidity measurement reading is greater than or equal to 80%, Moisture Vapor Treatment is required. Apply to terrazzo substrates according to Moisture Vapor Treatment Product Data Sheet.
- C. Protect other work from dust generated by grinding operations. Control dust to prevent air pollution and comply with environmental protection regulations.
  - 1. Erect and maintain temporary enclosures and other suitable methods to limit dust migration and to ensure adequate ambient temperatures and ventilation conditions during installation.

### **3.3 EPOXY 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 instructions and NTMA's "Terrazzo Specifications and Design Guide."
  3. Ensure that matrix components and fluids from grinding operations do not stain terrazzo by reacting with divider and control-joint strips.
  4. Delay fine grinding until heavy trade work is complete and construction traffic through area is restricted.
- B. Thickness: 3/8"
- C. Flexible Reinforcing Membrane
1. Membrane application for isolated cracking. Route out all cracks and fill with 100% solids epoxy. Apply Iso-Crack Epoxy Membrane (spread at 40 mils = 1.0 mm thickness) across the crack allowing 12 inches (304.8 mm) on either side. Imbed fiberglass scrim at a minimum of 9" into wet membrane and saturate with additional membrane.
- D. Primer: Apply to terrazzo substrates according to manufacturer's instructions.
- E. Strip Materials:
1. Divider and Accessory Strips:
    - a. Detail joints in accordance with NTMA Tech Bulletin T-24.
  2. Install strips in adhesive setting bed without voids below strips or mechanically anchor strips as required to attach strips to substrate.
    - a. Control/Construction Joints (saw cut, cold joint):
      - 1) Option 1- Preferred: Separate double L-type angles back to back with minimum 1/8" (3.2mm) width between. Fill joint and area between strips with semi-flexible joint filler.
      - 2) Option 2. Fill saw cut with 100% solids epoxy. Place single L-type angle strip shouldered on concrete, adjacent to the joint.
      - 3) Option 3: Buried Joint: Fill saw cut with 100% solids epoxy, followed by application of Iso-Crack Membrane (40 mils / 1.0 mm) with fiberglass mesh reinforcement embedded into the membrane. Note: Movement from the substrate may reflect through the finished floor.
    - b. Expansion Joint Strips: Separate double L-type angles, positioned back to back with minimum 1/8" (3.2 mm) width between. Fill area between strips with semi-flexible joint filler.
    - c. Random Crack Detail: For cracks over 1/16" width before surface preparation. Fill saw cut with 100% solids epoxy, followed by application of Iso-Crack membrane (40 mils / 1.0mm) with fiberglass mesh reinforcement embedded into the membrane. Note: Movement from the substrate may reflect through the finished flooring.
    - d. Special Considerations: For epoxy terrazzo exposed to direct sunlight use strip method B Option 1. (referenced above) every 8'-12' in each direction to compensate for thermal expansion/contraction.
- F. Placing Terrazzo:
1. Mix epoxy matrix with chips and fillers in ratios directed by manufacturer.
  2. Trowel apply terrazzo mixture over epoxy primer to provide a dense flat surface to top of divider strips. Allow to cure per manufacturer's recommendations before rough grinding.
- G. Rough Grinding: Grind with 24 grit silicon carbide or 24 grit turbo diamonds until all terrazzo strips and marble chips are uniformly exposed.
- H. Grouting, Polishing and Sealing:
1. Cleanse floor with clean water and rinse.
  2. Remove excess rinse water by wet vacuum, dry and fill voids with Epoxy Matrix or Clear Resin with a broadcast of limestone filler.
  3. Allow grout to cure.

4. With 200 grit diamond polishing pads or equivalent. All grout should be removed from the surface and terrazzo density should reflect a minimum of 70% aggregate exposure.
5. GC to provide protection as specified (Masonite or ram board) for remainder of construction.

### **3.4 CLEANING AND PROTECTION**

- A. Cleaning: Remove grinding dust from installation and wash all surfaces with Terroxy® Terra Clean or equivalent.
- B. Sealing: Apply slip and stain-resistant sealer that is chemically neutral with a pH factor between 7 and 10, that meets a standard coefficient of friction of 0.5 or higher, as measured by the James Machine (ASTM D-2047 Test Method), does not affect physical properties of terrazzo and complies with NTMA's "Terrazzo Specifications and Design Guide."
- C. Protection: Upon completion, the work shall be ready for final inspection and acceptance by the owner or his agent. Provide final protection and maintain conditions, in a manner acceptable to terrazzo contractor, that ensure terrazzo is without damage or deterioration.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  1. Aluminum.
  2. Plastic Materials
  3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 09 66 23**

## **SECTION 09 68 13 - TILE CARPETING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes modular carpet tile.
- B. Related Requirements:
  - 1. Division 6 Section "Rough Carpentry" for plywood floor installed with compact shelving top receive carpet tile finish.
  - 2. Division 09 Section "Resilient Base and Accessories" for resilient wall base and accessories installed with carpet tile.
  - 3. Division 09 Section "Access Flooring" for access flooring to receive carpet tile finish.

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:
    - a. Review delivery, storage, and handling procedures.
    - b. Review ambient conditions and ventilation procedures.
    - c. Review subfloor preparation procedures.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
  - 2. Include manufacturer's written installation recommendations for each type of substrate.
- B. Shop Drawings: For carpet tile installation, plans showing the following:
  - 1. Columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required in carpet tiles.
  - 2. Carpet tile type, color, and dye lot.
  - 3. Type of subfloor.
  - 4. Type of installation.
  - 5. Pattern of installation.
  - 6. Pattern type, location, and direction.
  - 7. Pile direction.
  - 8. Type, color, and location of edge, transition, and other accessory strips.
  - 9. Transition details to other flooring materials, including details where accessories are used to create transitions between carpet tile and floor finishes of different thickness.
- C. Samples: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
  - 1. Carpet Tile: Full-size Sample.
  - 2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch-long Samples.
- D. Samples for Initial Selection: For each type of carpet tile.

1. Include Samples of exposed edge, transition, and other accessory stripping involving color or finish selection.
- E. Samples for Verification: For each of the following products and for each color and texture required. Label each Sample with manufacturer's name, material description, color, pattern, and designation indicated on Drawings and in schedules.
1. Carpet Tile: A minimum of four full-size samples of each type and color selected by the Architect.
  2. Exposed Edge, Transition, and Other Accessory Stripping: 12-inch- long Samples.
- F. Product Schedule: For carpet tile. Use same designations indicated on Drawings.

## **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.
- C. Sample Warranty: For special warranty.

## **1.6 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
  1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
  2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

## **1.7 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials, from the same product run, 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..

## **1.8 QUALITY ASSURANCE**

- A. Installer Qualifications: An experienced installer who is certified by the International Certified Floorcovering Installers Association or who can demonstrate compliance with its certification program requirements.
- B. Fire-Test-Response Ratings: Where indicated, provide carpet tile identical to those of assemblies tested for fire response according to NFPA 253 by a qualified testing agency.
- C. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
  1. Build mockups at the following locations:
    - a. CPT1 (Staff): Media Editing Room 116.
    - b. CPT2 (Public): Media Recording Room 115.
  2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## **1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Comply with CRI's "CRI Carpet Installation Standard."

## **1.10 FIELD CONDITIONS**

- A. Comply with CRI's "CRI Carpet Installation Standard" for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.
- 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. Library shelving, millwork, and demountable partitions should be installed over carpet tiles unless noted or detailed otherwise.

## **1.11 WARRANTY**

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
  - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
  - 2. Failures include, but are not limited to, the following:
    - a. More than 10 percent edge raveling, snags, and runs.
    - b. Dimensional instability.
    - c. Excess static discharge.
    - d. Loss of tuft-bind strength.
    - e. Loss of face fiber.
    - f. Delamination.
  - 3. Warranty Period: 15 years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 CARPET TILE, GENERAL**

- A. Basis of Design: Provide the following carpet tiles as manufactured by Interface, or approved equivalent.
- B. CPT TILE 1
  - 1. Location: As indicated on Drawings.
  - 2. Colorline: Scandinavian from European Union Collection.
  - 3. Construction: Microtuft Patterned Level Loop Pile.
  - 4. Yarn System: Type 6.6 Nylon
  - 5. Yarn Manufacturer: Universal.
  - 6. Dye Method: 100% Solution Dyed.
  - 7. Tufted Yarn Weight: 12 oz/sq yd.
  - 8. Total Thickness: 0.19 inches.
  - 9. Size: 19.69" x 19.69" (50cm x 50 cm).
  - 10. Traffic Classification: Heavy.
  - 11. Total Recycled Content: 47% post-industrial.
  - 12. Backing: Graphlex.
  - 13. Color: Architect to select from full line of manufacturer's colors.
- C. CPT TILE 2
  - 1. Location: As indicated on Drawings.
  - 2. Colorline: H725 (Heuga) from European Union Collection.
  - 3. Construction: Tufted Plain Level Cut.

4. Yarn System: 100% Recycled Content Type 6 Nylon.
5. Yarn Manufacturer: Aquafil.
6. Dye Method: 100% Solution Dyed.
7. Pile Height: 0.17 inches.
8. Total Thickness: 0.284 inches.
9. Pile Density: 4,447 oz/sq yd.
10. Size: 19.69" x 19.69" (50cm x 50 cm).
11. Traffic Classification: Heavy.
12. Total Recycled Content: 65%
13. Backing: Graphlex.
14. Color: Architect to select from full line of manufacturer's colors.

D. CPT TILE 3

1. Location: Vestibule 300A.
2. Colorline: Step Repeat; SR899.
3. Construction: Tufted Textured Loop.
4. Yarn System: 100% Recycled Content Type 6 Nylon.
5. Yarn Manufacturer: Aquafil.
6. Dye Method: 100% Solution Dyed.
7. Tufted Yarn Weight: 26 oz/sq yd.
8. Total Thickness: 0.277".
9. Pile Height: 0.19 inches.
10. Pile Thickness: 0.14 inches.
11. Pile Density: 6,686 oz/cu yd.
12. Size: 19.69" x 19.69" (50cm x 50 cm).
13. Traffic Classification: Severe.
14. Total Recycled Content: 74%.
15. Backing: GlasBak.
16. Color: Architect to select from full line of manufacturer's colors.

## 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 comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.
  1. Adhesives shall have a VOC content of 50 g/L or less.
  2. Verify compatibility of adhesives with concrete slab-on-grade and slab-on-deck curing compounds, admixtures and sealers prior to their approval and use.
- C. Carpet Transition Shims: One piece carpet transition shims sized to provide smooth, even transition between top of carpet tile and adjacent floor finishes such as slate or granite tile as recommended by carpet manufacturer and approved by Architect.
- D. Metal Edge/Transition Strips: Extruded aluminum with mill finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.

- B. Examine carpet tile for type, color, pattern, and potential defects.
- C. Concrete Subfloors: Verify that concrete slabs comply with ASTM F 710 and the following:
  1. Slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine adhesion and dryness characteristics by performing bond and moisture tests recommended by carpet tile manufacturer.
  2. Subfloor finishes comply with requirements specified in Division 03 Section "Cast-in-Place Concrete" for slabs receiving carpet tile.
  3. Subfloors are free of cracks, ridges, depressions, scale, and foreign deposits.
- D. Wood and Metal (Access Floor) Subfloors: Verify the following:
  1. Underlayment surface is free of irregularities and substances that may interfere with adhesive bond or show through surface.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. General: Comply with CRI's "Carpet Installation Standards" and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes and depressions 1/8 inch wide or wider, and protrusions more than 1/32 inch unless more stringent requirements are required by manufacturer's written instructions.
- C. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Metal Substrates: Clean grease, oil, soil and rust, and prime if recommended in writing by adhesive manufacturer. Rough sand painted metal surfaces and remove loose paint. Sand aluminum surfaces, to remove metal oxides, immediately before applying adhesive.
- E. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

### **3.3 INSTALLATION**

- A. General: Comply with CRI 104, Section 14, "Carpet Modules," and with carpet tile manufacturer's written installation instructions.
- B. Installation Method: Consult Architect for installation direction for each type of carpet (Quarter Turn –vs- Monolithic.)
  1. Use manufacturer's TacTiles no glue installation system.
- C. Maintain dye-lot integrity. Do not mix dye lots in same area.
- D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings. Bind or seal cut edges as recommended by carpet tile manufacturer.
- E. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.

- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, nonstaining marking device.
- G. Install pattern parallel to walls and borders.
- H. Installation Method: Non Directional (all the same direction) or as directed by Architect.
- I. Access Flooring: Stagger joints of carpet tiles so carpet tile grid is offset from access flooring panel grid. Do not fill seams of access flooring panels with carpet adhesive; keep seams free of adhesive.

### **3.4 CLEANING AND PROTECTION**

- A. Perform the following operations immediately after installing carpet tile:
  - 1. Remove excess adhesive and other surface blemishes using cleaner recommended by carpet tile manufacturer.
  - 2. Remove yarns that protrude from carpet tile surface.
  - 3. Vacuum carpet tile using commercial machine with face-beater element.
- B. Protect installed carpet tile to comply with CRI's "Carpet Installation Standard," Section 20, "Protecting Indoor Installations."
- C. Protect carpet tile against damage from construction operations and placement of equipment and fixtures during the remainder of construction period. Use protection methods indicated or recommended in writing by carpet tile manufacturer.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 09 68 13**



## **SECTION 09 69 00 - ACCESS FLOORING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Access-flooring panels.
  - 2. Understructure.
- B. Related Requirements:
  - 1. Division 09 Section "Tile Carpeting" for carpet tiles applied over access flooring panels.
  - 2. Division 26 Sections for connection to ground of access flooring understructure and coordination.
  - 3. Division 27 Sections for voice and data cabling for service outlets and for coordination with understructure pedestals.

#### **1.3 COORDINATION**

- A. Coordinate location of mechanical and electrical work in underfloor cavity to prevent interference with access flooring pedestals.
- B. Mark pedestal locations on subfloor using a grid to enable electrical work to proceed without interfering with access-flooring pedestals.

#### **1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review connections between access flooring and mechanical and electrical systems.
  - 2. Review procedures for keeping underfloor space clean.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For access flooring:
  - 1. Details and sections with descriptive notes indicating materials, finishes, fasteners, typical and special edge conditions, accessories, and understructures.
- C. Samples: For the following products:
  - 1. Exposed Metal Accessories: Approximately 10 inches in length.
  - 2. One full-size floor panel, pedestal, and understructure unit for each type of access flooring required.
- D. Samples for Initial Selection: For each type of product and exposed finish.
- E. Samples for Verification: For the following products:
  - 1. Exposed Metal Accessories: Approximately 10 inches in length.
  - 2. One full-size floor panel, pedestal, and understructure unit for each type of access flooring required.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of access flooring.
- C. Product Test Reports: For each type of access-flooring material and exposed finish, performed by a qualified testing agency.

## 1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Panels:10% .
  - 2. Pedestals:10% .
  - 3. Grommet panels: 10 pieces.

## 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  - 1. Build mockup of typical access flooring, as shown on Drawings. Size to be an area no smaller than 5' x 5'.
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install access flooring until spaces are enclosed, ambient temperature is between 50 and 90 deg F, and relative humidity is not less than 20 and not more than 70 percent.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide access flooring capable of complying with the following performance requirements according to testing procedures in CISCA's "Recommended Test Procedures for Access Floors":
  - 1. Concentrated Loads: 32 sq in per triangular tile
    - a. 500 lb on one square inch with the following deflection and permanent set:
    - b. Top-Surface Deflection: 0.057 inch.
    - c. Permanent Set: 0.002 inch.
    - d. Recovery: >99%.
  - 2. Ultimate Point Loads: 32 sq in per triangular tile.
    - a. Edge – 1291 lb on one square inch. Safety factor ultimate to concentrated > 2.5.1.
    - b. Center – 2399 lb on one square inch. Safety factor ultimate to concentrated > 4.5.1.
  - 3. Rolling Loads: (net weight per wheel)
    - a. 500 lb (3" hard phenolic tread wheel at 10 cycles < 0.02" permanent set)
    - b. 350 lb (6" soft alathane tread wheel at 10,000 cycles < 0.02" permanent set)
  - 4. Supports: Axial load 4,200 lb. Slow buckling in failure.

5. System Uniform Load: 320 psf < 0.02" deflection.

B. Fire Performance:

1. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - a. Flame-Spread Index: 25 or less.
  - b. Smoke-Developed Index: 450 or less.

## 2.2 FLOOR PANELS

A. Floor Panels, General: Provide modular panels interchangeable with other field panels without disturbing adjacent panels or understructure.

1. Size: Primary tile to be 32 square inch triangle. Rectangular, square, room edge and other specialty tiles to be supplied as required by design.
2. Attachment to Understructure: By gravity.

B. **Basis-of-Design Product:** Subject to compliance with requirements, provide **Low-Profile Floor by Steelcase**, or approved equivalent.

C. Floor Panels:

1. Galvanized steel.
  - a. Triangle Tile: 32 square inch, for primary field use.
  - b. Grommet Triangle Tile: with 6653 Solar Black plastic grommet.
  - c. Rectangular and Square Tile – for field cutting at columns and other obstructions.
  - d. Floor Box Access Tile – to be used over each Architectural Power low-profile floor box.
  - e. Distribution Tile – to be used over power distribution module, transition module, zone box, and consolidation point.
  - f. Edge Trim – field cut for exposed edges.
  - g. Corner Edge Trim – with closed ends to finish exposed edge at end of run.
  - h. Wall Scribe Trim – field cut for flush, finished edge against a building wall.
  - i. Ramp Kit – special sloping tiles for ramp construction.
  - j. Ramp Edge Trim – finishes exposed edges of ramp.

## 2.3 UNDERSTRUCTURE

A. Pedestals: 2-1/2" high x 3-7/8" diameter black plastic cylinder pucks with grooved top faces to receive tile edges.

## 2.4 FABRICATION

A. Fabrication Tolerances:

1. Size: Plus or minus 0.020 inch of required size.
2. Squareness: Plus or minus 0.015 inch between diagonal measurements across top of panel.
3. Flatness: Plus or minus 0.035 inch, measured on a diagonal on top of panel.

B. Panel Markings: Clearly and permanently mark floor panels on their underside with panel type and concentrated-load rating.

## 2.5 ACCESSORIES

A. Provide modular underfloor junction boxes with whips in the number and configuration shown on the Electrical and Technology Drawings.

B. Perimeter Support: Where indicated, provide manufacturer's standard method for supporting panel edge and forming transition between access flooring and adjoining floor coverings at same level as access flooring.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, with Installer and manufacturer's authorized representative present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  - 1. Verify that substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of conditions and deleterious substances that might interfere with attachment of pedestals.
  - 2. Verify that concrete floor sealer and finish have been applied and cured.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Lay out floor panel installation to keep the number of cut panels at floor perimeter to a minimum. Avoid using panels cut to less than 6 inches.
- B. Locate each pedestal, complete any necessary subfloor preparation, and vacuum subfloor to remove dust, dirt, and construction debris before beginning installation.

### **3.3 INSTALLATION**

- A. Install access-flooring system and accessories under supervision of access-flooring manufacturer's authorized representative to produce a rigid, firm installation that complies with performance requirements and is free of instability, rocking, rattles, and squeaks.
- B. Adjust pedestals to permit top of installed panels to be set flat, level, and to proper height.
- C. Install flooring panels securely in place, properly seated with panel edges flush. Do not force panels into place.
- D. Scribe perimeter panels to provide a close fit with adjoining construction with no voids greater than 1/8 inch where panels abut vertical surfaces.
- E. Grounded Flooring Access Panel Systems: Ground flooring system as recommended by manufacturer and as needed to comply with performance requirements for electrical resistance of floor coverings.
  - 1. See Electrical Specification for grounding requirements.
- F. Clean dust, dirt, and construction debris caused by floor installation, and vacuum subfloor area as installation of floor panels proceeds.
- G. Install access flooring without change in elevation between adjacent panels and within the following tolerances:
  - 1. Plus or minus 1/16 inch in any 10-foot distance.
  - 2. Plus or minus 1/8 inch from a level plane over entire access-flooring area.

### **3.4 PROTECTION**

- A. Prohibit traffic on access flooring for 24 hours and removal of floor panels for **[72 <Insert number> hours** after installation, to allow pedestal adhesive to set.
- B. Replace access-flooring panels that are stained, scratched, or otherwise damaged or that do not comply with specified requirements.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.
- C. Plan and coordinate roofing work to minimize the generation or cutoffs and waste.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 09 69 00**

## **SECTION 09 91 23 - PAINTING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes surface preparation and the application of paint systems on the following substrates:
  - 1. Concrete.
  - 2. Steel.
  - 3. Wood.
  - 4. Gypsum board.
  - 5. Concrete masonry units (CMUs).
  - 6. Galvanized metal.
  - 7. Aluminum (not anodized or otherwise coated).
- B. Related Requirements:
  - 1. Division 03 Section "Cast-in-Place Concrete" for sealer for exterior concrete slabs.
  - 2. Division 05 Section "Structural Steel Framing" for shop priming structural steel.
  - 3. Division 05 Sections "Metal Fabrications," "Decorative Metal Stairs & Railings" and "Decorative Metal" and for products painted under this section and shop priming requirements.
  - 4. Division 06 Section "Interior Architectural Woodwork" for products painted or stained under this section.
  - 5. Division 07 Section "Applied Fireproofing" for intumescent coating applied to rated interior structural steel.
  - 6. Division 08 Sections "Access Doors" and "Flush Wood Doors" for doors painted under this section.
  - 7. Division 09 Sections "Gypsum Board" and "Gypsum Board Shaft Walls" for gypsum products painted under this section.
  - 8. Division 09 Section "Mineral Stains" for coatings on exterior concrete at areaway and loading dock.

#### **1.3 DEFINITIONS**

- A. MPI Gloss Level 1: Not more than five units at 60 degrees and 10 units at 85 degrees, according to ASTM D523.
- B. MPI Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
- C. MPI Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D523.
- D. MPI Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D523.
- E. MPI Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D523.
- F. MPI Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D523.
- G. MPI Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D523.

## 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions.
  - 1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
  - 2. Indicate VOC content.
- B. Samples for Initial Selection: For each type of topcoat product.
- C. Samples: Prior to beginning work, Architect will furnish color chips or samples for surfaces to be painted. Use representative colors to match Architect's chips or samples when preparing samples for review. Submit samples for Architect's review of color and texture only. Provide a listing of material and application for each coat of each finish sample.
  - 1. On 12" x 12" hardboard, provide two samples of each color and material, with texture to simulate actual conditions. Resubmit samples as requested by Architect until acceptable sheen, color and texture is achieved.
  - 2. On actual wall surfaces and other building components, duplicate painted finishes of prepared samples. Provide full coat finish samples on at least 100 sq. ft. of surface, as directed, until required sheen color and texture is obtained; simulate finished lighting conditions for review of in-place work.
  - 3. For non-ferrous and ferrous metal, provide two 4-inch square samples of flat metal and two 8 inch long samples of solid metal for each color and finish.
  - 4. Final acceptance of colors will be from samples applied on the job.
- D. Samples for Verification: For each type of paint system and in each color and gloss of topcoat.
  - 1. Submit Samples on rigid backing, 8 inches square.
  - 2. Apply coats on Samples in steps to show each coat required for system.
  - 3. Label each coat of each Sample.
  - 4. Label each Sample for location and application area.
- E. Product List: For each product indicated, include the following:
  - 1. Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

## 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Paint: 5 percent, but not less than 1 gal. of each material and color applied.

## 1.6 QUALITY ASSURANCE

- A. Mockups: Apply mockups 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.
    - a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft.
    - b. Other Items: Architect will designate items or areas required.
    - c. Simulate finished lighting conditions for review of mockups.
  - 2. Final approval of color selections will be based on mockups.
    - a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
  - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

B. MPI Standards:

1. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with manufacturer's name, material and product brand name, and lot number, if any.
- B. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.
  1. Maintain containers in clean condition, free of foreign materials and residue.
  2. Remove rags and waste from storage areas daily.

## 1.8 FIELD CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by The Sherwin-Williams Company, Tnemec, Inc., or approved equivalent.
- B. Products: Subject to compliance with requirements, provide product listed in the Interior Painting Schedule for the paint category indicated.

### 2.2 PAINT, GENERAL

- A. Material Compatibility:
  1. Materials for use within each paint system shall be 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, products shall be recommended in writing by topcoat manufacturers for use in paint system and on substrate indicated.
- B. Colors: Match Architect's samples.

## 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 the Work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
  1. Concrete: 12 percent.
  2. Masonry (Clay and CMUs): 12 percent.



3. Wood: 15 percent.
  4. Gypsum Board: 12 percent.
- C. Gypsum Board Substrates: Verify that finishing compound is sanded smooth.
- D. Verify suitability of substrates, including surface conditions and compatibility, with existing finishes and primers.
- E. Proceed with coating application only after unsatisfactory conditions have been corrected.
1. Application of coating indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates and paint systems indicated.
- B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.
1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.
- C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.
- D. Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
- A. Ferrous Metals: Clean ferrous surfaces, including galvanized or shop-coated surfaces, of oil, grease, dirt, loose mill scale, spatter, slag, flux deposits, and other foreign substances by solvent or mechanical cleaning.
1. Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
  2. Touch-up shop-applied prime coats wherever damaged or bare, where required by other sections of these specifications. Clean and touch-up with same type shop primer.
  3. Galvanized Metal: Clean per SSPC-SP1 using detergent and water or a degreasing cleaner to remove greases and oils. Apply a test area, priming as required. Allow the coating to dry at least one week before testing. If adhesion is poor, Brush Blast per SSPC-SP7 is necessary to remove these treatments.
  4. All interior and exterior ferrous metals exposed in finished construction shall be cleaned in accordance with Steel Structures Painting Council (SSPC). Visual standards are available through the Steel Structures Painting Council; ask for SSPC-VIS 1-89.
    - a. Commercial Blast Cleaning, SSPC-SP6 or NACE 3 - for structural steel and all partially or fully exposed interior and exterior ferrous metal, except for interior ferrous metal pipe and bar railings and metal pan stairs in fully enclosed exit stairs, clean to attain an average profile depth of 1.5 mils. A Commercial Blast Cleaned surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, mill scale, rust, paint, oxides, corrosion products, and other foreign matter, except for staining. Staining shall be limited to no more than 33 percent of each square inch of surface area and may consist of light shadows, slight streaks, or minor discoloration caused by stains of rust, stains of mill scale, or stains of previously applied paint. Before blast cleaning, visible deposits of oil or grease shall be removed by any of the methods specified in SSPC-SP1 or other agreed upon methods.

5. Interior and exterior ferrous metals not exposed to finished construction shall be cleaned in accordance with Steel Structures Painting Council (SSPC). Visual standards are available through the Steel Structures Painting Council; ask for SSPC-VIS 1-89.
    - a. Solvent Cleaning, SSPC-SP1: Solvent cleaning is a method for removing all visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants. Solvent cleaning does not remove rust or mill scale. Change rags and cleaning solution frequently so that deposits of oil and grease are not spread over additional areas in the cleaning process. Be sure to allow adequate ventilation.
  6. All foundry and mill marks shall be removed by grinding or other approved method, and surfaces finished smooth and flush. Any marks showing through finished work shall be removed and the entire surface of item repainted at no additional cost to the Owner. Spot touch-up on finish coats will not be accepted.
- B. Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- C. Aluminum Substrates: Remove loose surface oxidation.
- D. Wood Substrates:
1. Scrape and clean knots and apply coat of knot sealer before applying primer.
  2. Sand surfaces that will be exposed to view and dust off.
  3. Prime edges, ends, faces, undersides, and backsides of wood.
  4. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- E. Gypsum Board Substrates: Do not begin paint application until finishing compound is dry and sanded smooth.

### 3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."
1. Use applicators and techniques suited for paint and substrate indicated.
  2. Paint surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
  3. Paint front and backsides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.
  4. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  5. Primers specified in painting schedules may be omitted on items that are factory primed or factory finished if acceptable to topcoat manufacturers.
- B. Tint each undercoat a lighter shade to facilitate identification of each coat if multiple coats of same material are to be applied. Tint undercoats to match color of topcoat but provide sufficient difference in shade of undercoats to distinguish each separate coat.
- C. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- D. 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.
- E. Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:

1. Paint the following work where exposed in equipment rooms:
  - a. Any item recommended to be painted by manufacturer or subject to corrosion if left unpainted.
2. Paint the following work where exposed in occupied spaces:
  - a. Equipment, including panelboards.
  - b. Uninsulated metal piping.
  - c. Uninsulated plastic piping.
  - d. Pipe hangers and supports.
  - e. Metal conduit.
  - f. Plastic conduit.
  - g. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
  - h. Other items as directed by Architect.
3. Paint portions of internal surfaces of metal ducts and blankoff panels, without liner, behind air inlets and outlets that are visible from occupied spaces.
4. Paint any structure, framing or sheathing visible above ceilings or through joints and reveals.

### **3.4 FIELD QUALITY CONTROL**

- A. Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
  1. Contractor shall touch up and restore painted surfaces damaged by testing.
  2. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written recommendations, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written recommendations.

### **3.5 CLEANING AND PROTECTION**

- A. At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
- B. After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- C. 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.
- D. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

### **3.6 INTERIOR PAINTING SCHEDULE**

- A. Existing Cast in Place Concrete Floor Slabs – interior use only.
  1. Pigmented coating: Sherwin-Williams, or approved equivalent.
    - a. Two finish coats: ArmorSeal 8100 WB Epoxy coating
  2. Penetrating Sealer: Sherwin-Williams, or approved equivalent.
    - a. Two finish coats: GP 3477 Epoxy Water Emulsion Sealer
- B. Existing Cast in Place Concrete Walls.
  1. Sherwin-Williams, or approved equivalent.
    - a. Primer: Loxon Concrete and Masonry Primer
    - b. Two finish coats: ProMar 200 Zero VOC eggshell
- C. CMU
  1. Sherwin-Williams, or approved equivalent.

- a. Filler: PrepRite Block Filler
  - b. Two finish coats: ProMar 200 Zero VOC eggshell.
- D. Ferrous Metal: Exterior Structural Steel columns to be enclosed with Column Covers.
  - 1. Tnemec Series 90-97 Tneme-Zinc, or approved equivalent.
- E. Ferrous Metal covered with new Fluid Applied Insulation Coating, where exposed in the interior of the building.
  - 1. Tnemec Series 115 UniBond dryfall, or approved equivalent.
- F. Ferrous Metal: Exposed Structural Steel, decking, metal fabrications and existing fireproofing.
  - 1. Sherwin-Williams, or approved equivalent.
    - a. Primer (Ferrous and Non-Ferrous Metal): ProIndustrial Pro-cryl Universal Primer
    - b. Two coats: Low VOC Waterborne Acrylic Dryfall, Flat B42-W00081
- G. Ferrous Metal, including but not limited to metal stringers, risers and railings, and decorative metal.
  - 1. Sherwin-Williams, or approved equivalent.
    - a. Primer: ProIndustrial Pro-Cryl Universal Primer
    - b. Two finish coats: ProIndustrial WB Alkyd Urethane Enamel, B53 series, semi-gloss
- H. Ferrous Metal: Corrosion resistant coating for existing steel angles to remain in service.
  - 1. Provide one of the products listed below, or an approved equal.
    - a. Tnemec, Inc: Omnithane Series 1
    - b. Sherwin-Williams: Corothane 1 GalvaPac Zinc
    - c. Apply per manufacturer's instructions for specific conditions.
- I. Ferrous Metal: Approved topcoats for intumescent coating specified in Division 07 Section "Applied Fireproofing."
  - 1. Sherwin-Williams, or approved equivalent.
  - 2. Two finish coats: Match adjacent SHEEN with one of the approved topcoats
    - a. ProMar 200 Zero VOC, Flat
    - b. ProMar 200 Zero VOC, Eggshell
    - c. ProIndustrial DTM Acrylic, Semi-Gloss
- J. Galvanized and Non-Ferrous Metal.
  - 1. Sherwin-Williams, or approved equivalent.
    - a. Primer: ProIndustrial Pro-Cryl Universal Primer
    - b. 2 finish coats: ProIndustrial WB Alkyd Urethane Enamel, B53 series, semi-gloss
- K. Wood Architectural Trim – painted hardwood.
  - 1. Sherwin-Williams, or approved equivalent.
    - a. Primer: Mult-Purpose Latex Primer
    - b. Two finish coats: Solo 100% Acrylic Latex, semi-gloss
- L. Gypsum – eggshell finish
  - 1. Sherwin-Williams, or approved equivalent.
    - a. Primer: ProMar 200 Zero VOC Primer
    - b. Two finish coats: ProIndustrial Pre-Catalyzed Water-Based Epoxy, eg-shell
- M. Gypsum – ceilings and soffits – flat finish.
  - 1. Sherwin-Williams, or approved equivalent.
    - a. Primer: ProMar Ceiling Paint flat
    - b. Finish coat: ProMar Ceiling Paint flat

**END OF SECTION 09 91 23**

## **SECTION 09 93 00 – MINERAL STAINS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Application of water repellent primer and two coats of sol-silicate stain. Specification includes limited surface preparation with concrete cleaner.
  - 2. Clear heavy duty exterior sealer for concrete.
- B. Related Requirements:
  - 1. Division 03 Section "Maintenance of Cast in Place Concrete."

#### **1.3 REFERENCES**

- A. General: 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.
- B. ASTM (ASTM):
  - 1. ASTM E 96, "Standard Test Methods for Water Vapor Transmission of Materials."
  - 2. ASTM E 514, "Standard Test Method for Water Penetration and Leakage Through Masonry."
  - 3. ASTM G 154, "Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials."
  - 4. ASTM D 6886-12, "Standard Test Method for Determination of the Individual Volatile Organic Compounds (VOCs) in Air-Dry Coatings by Gas Chromatography."
- C. Deutsches Institute for Normung (DIN), European Standard (EN), and International Organization for Standardization (ISO):
  - 1. DIN EN 1062, manufacturing standard for sol-silicate coating.
  - 2. ISO 6504-3, "Paints and varnishes - Determination of hiding power - Part 3: Determination of contrast ratio of light-colored paints at a fixed spreading rate."
  - 3. ISO 2813, "Paints and varnishes - Determination of specular gloss."
  - 4. EN 1062-3, "Paints and varnishes - Coating materials and coating systems for exterior masonry and concrete - Part 3: Determination of liquid water permeability."
  - 5. DIN EN 1504-2, "Products and systems for the protection and repair of concrete structures - Definitions, requirements, quality control and evaluation of conformity - Part 2: Surface protection systems for concrete."
  - 6. DIN EN ISO 7783-2, "Coating materials and coating systems for exterior masonry and concrete - Part 2: Determination and classification of water-vapor transmission rate (permeability)."
  - 7. DIN 4102-A2, "Fire Behavior of Building Materials and Building Components - Part 2: Building Components; Definitions, Requirements and Tests."

#### **1.4 DEFINITIONS**

- A. Concrete cleaner: An acidic liquid cleaner.
- B. Primer: A liquid water repellent.
- C. Silicate stain, base coat: The first applied coat of the premixed sol-silicate stain.

- D. Silicate stain, top coat: The second applied coat of the premixed sol-silicate stain.
- E. Dilution: A sol-silicate based diluent.
- F. Application Ratio: A mixture of silicate stain and silicate dilution expressed as a ratio of one to the other to achieve the proper color transparency for the silicate stain.
- G. Approved Application: The application ratio and application steps derived from the approved mock up from Section 1.6, B.6.e. Approved Application.

## **1.5 SYSTEM DESCRIPTION**

- A. A materials-compatible highly vapor permeable water and weather-resistant decorative stain system.
  - 1. Concrete Cleaner: A silicic acid based cleaner used to remove mold release oils, and soiling from concrete and mineral surfaces.
  - 2. Primer: A solvent-free liquid silane water repellent applied to a mineral substrate where it is pulled into the open pores by capillary draw to capacity. Curing in a chemical reaction with humidity in the substrate, a micro-thin silica gel lining forms within the pores leaving them open to diffusion. The silica gel lining reduces surface tensions thus breaking the capillary draw of water and salts into the substrate and resisting wind-driven rain.
  - 3. Silicate stain: An incombustible two coat system comprising a base coat and a top coat.
    - a. Silicate stain penetrates the surface and in a chemical reaction combines with the substrate through chemical and mechanical bonds forming a hard amorphous microporous layer with extremely high vapor permeability.
    - b. Unaffected by acids, UV exposure, or air-borne pollutants.
    - c. Unique alkaline mineral layer structure resists liquid water penetration into the coated substrate and maintains moisture balance through vapor diffusion to keep wall assemblies breathable and dry, thus resisting mold and biological growth.
    - d. Will not reduce substrate vapor permeability.

## **1.6 SUBMITTALS**

- A. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications. Provide published documentation describing materials, characteristics, and limitations.
- B. Samples: Submit samples for verification purposes, fabrication techniques and workmanship.
- C. Manufacturer's Instructions: Submit manufacturer's instructions including technical data sheets, material safety data sheets, mixing instructions, application requirements, special procedures, and conditions requiring special attention.

## **1.7 QUALITY ASSURANCE**

- A. Qualifications:
  - 1. Manufacturer Qualifications: Provide evidence that Manufacturer is a firm engaged in the manufacture of silicate stains of types required, and whose products have been in satisfactory use in similar service for a minimum of fifteen years.
  - 2. Applicator Qualifications:
    - a. Provide evidence Applicator is a firm having a minimum of three years of successful application experience with projects similar in type and scope to that required for this Project, and having passed a product certification training course provided by the manufacturer prior to the execution of this unit of work.
- B. Mock ups:

1. Prior to application of the work, provide mock ups for each type of finish and application to verify selections made under sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution.
2. Locate mock ups as directed by the Architect.
3. Demonstrate the proposed range of aesthetic effects and workmanship to be expected in the completed work.
4. Obtain the Architect's acceptance of mock ups before start of final unit of work.
5. Determine Application Ratio:
  - a. Locate area(s) to receive the silicate stain mock up samples. Prepare surfaces as directed in Sections 3.1 EXAMINATION, 3.2 PREPARATION, and 3.3 APPLICATION.
  - b. Determine a range of transparency to achieve desired optical equalization in two coats for aesthetic evaluation as directed by KEIM representative.
  - c. Prepare sample material: Provide minimum three transparent examples of silicate stain and dilution mixed in a ratio of one to the other. Maintain a record of prepared stain color and dilution ratio mixtures.
  - d. Stir well for one minute and keep well-stirred thereafter for color consistency. Apply sample material as directed in Section 2.4 FINISHES. Apply the prepared samples in two coats allowing minimum 24 hours between coats. If necessary, adjust ratios to obtain the desired results. Results may be evaluated for approval after final coat has cured minimum 24 hours. Obtain manufacturer's written instructions for application outside of the above parameters.
  - e. Approved Application: Maintain a record of the approved mock up stain color, application ratio, and application steps to incorporate into final unit of work to ensure color consistency and appearance aesthetics.

## **1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with manufacturer's name, material and product brand name, and lot number, if any.
- B. Store materials in their original undamaged packages and containers inside a well ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

## **1.9 PROJECT CONDITIONS**

- A. Environmental Requirements:
  1. Do not apply in freezing conditions, when rain is expected, or in high winds.

## **1.10 WARRANTY**

- A. Provide manufacturer's written product warranty.
  1. Warranty period from date of Substantial Completion is 10 years.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Basis of Design:
  1. Items specified are to establish a standard of quality for design, function, materials, compatibility, performance, warranty, and appearance.

2. Equivalent products by listed manufacturers are acceptable.
  3. The Architect is the sole judge of the basis of what is equivalent.
- B. Listed Manufacturers
1. KEIM Mineral Coatings of America, Inc., Charlotte, North Carolina, or approved equivalent.

## 2.2 MATERIALS FOR STAINING OF CONCRETE AT AREAWAY

- A. Concrete Cleaner: Provide a pretreatment and cleaning agent meeting or conforming to:
1. Fluorosilicic acid based.
  2. Is diluted with water.
  3. Upon application immediately reacts to form harmless compounds.
  4. Clear, colorless liquid.
  5. No VOC.
  6. Basis of Design: "KEIM Concrete Cleaner", KEIM Mineral Coatings of America, Inc. or approved equivalent.
- B. Primer: Provide a water repellent meeting or conforming to:
1. Silane technology with 100% active ingredient.
  2. Highly vapor permeable. Leaves pores open to diffusion.
  3. Will not change appearance of treated surfaces.
  4. Will not yellow over time.
  5. Solvent-free.
  6. Very low VOC, less than 10 grams per liter VOC.
  7. Basis of Design: "KEIM Silan 100", KEIM Mineral Coatings of America, Inc. or approved equivalent.
- C. Silicate stain, base and top coat: Provide sol-silicate based mineral stain meeting or conforming to:
1. DIN EN 1062, manufacturing standard for sol-silicate coating.
  2. DIN EN 1504-2/2.2, Products and systems for the protection and repair of concrete structures/Surface protection systems for concrete (when applied together with KEIM Silan 100)
  3. DIN 4102-A2, non-flammable standard – will not burn.
  4. ASTM E 96 Vapor Permeability – 75 to 85 perms.
  5. ASTM G 154 Accelerated Weathering – no fading, cracking, peeling.
  6. ASTM D 6886-12 Standard Test Method for Individual Volatile Organic Compounds (VOCs) – Less than 1 gram per liter VOC (Volatile Organic Content).
  7. Tinted to the desired finish color.
  8. Basis of Design: "KEIM Concretal-Lasur", KEIM Mineral Coatings of America, Inc. or approved equivalent.
- D. Dilution for Silicate stain: Provide sol-silicate dilution meeting or conforming to:
1. DIN 4102-A2, non-flammable standard – will not burn.
  2. ASTM E 96 Vapor Permeability – 75 to 85 perms.
  3. ASTM D 6886-12 Standard Test Method for Individual Volatile Organic Compounds (VOCs) – Less than 1 gram per liter VOC (Volatile Organic Content).
  4. Basis of Design: "KEIM Concretal-Dilution", KEIM Mineral Coatings of America, Inc. or approved equivalent.

## 2.3 MATERIALS FOR SEALING CONCRETE AT LOADING DOCK

- A. Concrete Cleaner: Provide a pretreatment and cleaning agent meeting or conforming to:
1. Fluorosilicic acid based.
  2. Is diluted with water.
  3. Upon application immediately reacts to form harmless compounds.
  4. Clear, colorless liquid.



5. No VOC.
  6. Basis of Design: "KEIM Concrete Cleaner", KEIM Mineral Coatings of America, Inc. or approved equivalent.
- B. Heavy duty clear concrete sealer: "KEIM Faceal Oleo HD" as manufactured by KEIM Mineral Coatings of America, Inc., or approved equivalent.
1. Functionally-substituted fluorinated acrylic copolymer in an aqueous phase.
  2. Bonds permanently with the substrate.
  3. Vapor Permeability according to DIN 52615 mod.: no measurable change.
  4. pH value = 5.
  5. VOC Content = 20 g/kg.
  6. Air and substrate temperature for application: 41 to 86 degrees F.
  7. Remove all surplus product on the surface.

## 2.4 EQUIPMENT

- A. Tools:
1. Concrete Cleaner: Apply by natural bristle façade brush, rinse off with clean water.
  2. Primer: Apply by natural bristle brush, roller, or low pressure sprayer.
  3. Silicate stain, base and top coats: Apply by natural bristle façade brush, professional roller, or professional airless spray equipment and back-roll as required for even distribution.

## 2.5 FINISHES

- A. Concrete Cleaner: Leave surface clean from particles.
- B. Primer: Apply wet coats sponging off material that is not absorbed.
- C. Silicate stain, base and top coats:
1. Apply in full coverage evenly distributed coats to a smooth mineral matte finish without lap lines, voids, "holidays", or drips. Compare manufacturer-verified mock up consumption data with application consumption data to ensure enough product is applied.
  2. Maintain a wet edge to prevent sight lines and textural differences.
  3. Apply enough product to prevent shading and textural differences that contribute to striping, especially with the base coat. Applying inadequate amount of product can produce unexpected results.
  4. When rolling product, quickly coat the surface and then gently even it up with the roller. Roll off in same direction across façade to prevent shading differences that affect appearance of color.
  5. When spraying product:
    - a. Do not strain silicate stain.
    - b. Remove paint filters from spray gun and spray pump.
    - c. Use only new hoses. Used hoses may contain paint thinners or solvents.
    - d. Paint thinners and cleaning solvents are not compatible with silicate stain.
    - e. Clear gun and spray equipment with warm soapy water and rinse well with clean water to remove residual paint thinners and solvents.
    - f. Never use tips with smaller orifices than recommended. Smaller tips clog and prevent proper stain application. Improper application voids warranty and shortens longevity of the stain.
    - g. Prevent overspray drift or misting onto glass objects.
  6. When working from scaffolding, work as a team moving across façade maximum eight (8) vertical feet per applicator to ensure complete coverage and wet edge left to right and top to bottom of each section.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verification of Conditions: Confirm by examination the areas and conditions under which the work is to be applied for compliance with manufacturer's instructions. Do not proceed with the work until unsatisfactory conditions have been corrected.
1. Verify substrate is secure, sound, dry, and absorbent, and free of dirt, grease, salts, oil-based paints, release agents, curing agents, and other bond breakers.
  2. Verify substrate has no pretreatments or priming materials applied unless such conditions are approved by manufacturer.
  3. Verify surfaces or materials to be coated are fully cured to manufacturer recommendations.
  4. Confirm coating surfaces are less than 40 percent relative humidity as measured by a masonry moisture meter prior to application of silicate stain.
  5. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Applicator.

### **3.2 PREPARATION**

- A. Protection:
1. Lay ground cloths and take measures as necessary to protect surfaces subject to contact by products specified by this Section.
  2. Concrete cleaner may bleach concrete.
  3. Primer may bond to glass.
  4. Silicate stain or dilution may etch or bond to glass, metal, and concrete.

### **3.3 APPLICATION**

- A. Conform to reviewed product data, manufacturer's written instructions, and provisions of the Contract Documents.
- B. Plan the work properly.
1. Maintain temperature during and after application. Substrate and ambient air temperature must be between 41 °F (5 °C) and 86 °F (30 °C).
  2. Work ahead of the sun on shaded façades to avoid working on hot substrates.
  3. Work to logical stopping points (corners, seams, architectural features, etc.).
  4. Apply silicate stains as directed by 2.4 FINISHES.
  5. Protect from wind and rain prior to, during, and for a minimum 24 hours after application.
  6. Obtain manufacturer's written instructions for application outside of the above parameters.
- C. Concrete Cleaner:
1. Dampen substrate with water. When dry to touch, proceed with concrete cleaner.
  2. Dilute 1:3 (1 part concrete cleaner to 3 parts clean water) with clean water.
  3. Apply generously to substrate from bottom working to the top. Reaction is immediate.
  4. Rinse substrate with water from bottom to top and down.
  5. Allow substrate to completely dry.
- D. Primer:
1. Apply in multiple flooding coats over surface allowing 10 to 15 minutes penetration time between coats until substrate will not absorb more. Blot unabsorbed material from substrate.
  2. Allow water repellent 4 hours to penetrate and before 24 hours lapse, apply the Silicate stain base coat. The Primer develops its repellency over the 24 hour period.
  3. If 24 hours lapse before the Silicate stain base coat can be applied, reapply the Primer, wait 4 hours, and continue with the Silicate stain base coat application.

- E. Silicate stain:
1. Base coat:
    - a. Prepare silicate stain and dilution in the approved product application ratio determined in Section 1.6, B. 6. e. Approved Application.
    - b. Stir well by hand or 600-800 RPM mixing equipment to ensure color is uniform throughout the material. Keep mixture continuously stirred during application.
    - c. Apply base coat of prepared silicate stain.
    - d. Allow minimum 24 hours drying time.
  2. Top coat:
    - a. Prepare silicate stain and dilution in the approved product application ratio determined in Section 1.6, B. 6. e. Approved Application.
    - b. Stir well by hand or 600-800 RPM mixing equipment to ensure color is uniform throughout the material. Keep mixture continuously stirred during application.
    - c. Apply top coat of prepared silicate stain.
  3. Touch up:
    - a. Transparent stains are difficult to touch up. Some diluted colors touch up well, some do not. Always perform a test and allow the touch up to cure minimum 12 hours before evaluation. Colors become lighter upon drying.
    - b. When possible, use the same tools and techniques from the application for best results.
    - c. Articulate the application confining the touch up to the borders of the repair.

### **3.4 CLEANING**

- A. Primer: Clean tools immediately with benzene or similar solvent.
- B. Concrete cleaner and stain products: Clean tools, spills, and accidental drips immediately with plenty of water.
- C. Leave applications clean and premises free from residue and debris from work of this Section.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  1. Aluminum.
  2. Plastic Materials
  3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 09 93 00**

## **SECTION 10 11 00 - VISUAL DISPLAY SURFACES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  1. Markerboards.
  2. Glass writing boards.
  3. Cork tackboards.

#### **1.3 DEFINITIONS**

- A. Tack board: Framed or unframed, tackable, visual display board assembly.
- B. Visual Display Board Assembly: Visual display surface that is factory fabricated into composite panel form, either with or without a perimeter frame; includes chalkboards, markerboards, and tackboards.

#### **1.4 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  1. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.
- B. Shop Drawings: For visual display units.
  1. Include plans, elevations, sections, details, and attachment to other work.
  2. Show locations of panel joints. Show locations of field-assembled joints for factory-fabricated units too large to ship in one piece.
  3. Include sections of typical trim members.
- C. Samples for Initial Selection: For each type of visual display unit indicated, for units with factory-applied color finishes, and as follows:
  1. Samples of facings for each visual display panel type, indicating color and texture.
  2. Actual factory-finish color samples, applied to aluminum substrate.
  3. Include accessory Samples to verify color selected.
- D. Samples for Verification: For each type of visual display unit indicated.
  1. Visual Display Panel: Not less than 8-1/2 by 11 inches, with facing, core, and backing indicated for final Work. Include one panel for each type, color, and texture required.
  2. Trim: 6-inch-long sections of each trim profile.
  3. Display Rail: 6-inch-long section of each type.
  4. Support System: 6-inch-long sections.
  5. Accessories: Full-size Sample of each type of accessory.
- E. Product Schedule: For visual display units.

## **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each visual display unit, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Sample Warranties: For manufacturer's special warranties.

## **1.7 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For visual display units to include in maintenance manuals.

## **1.8 QUALITY ASSURANCE**

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
  - 1. Build mockups of the following, including accessories:
    - a. Glass Writing Board: Group Study Room 232.
    - b. Cork Tackboard: Print/Copy Room 205
    - c. Markerboard: Digital Humanities 204
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## **1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver factory-built visual display surfaces, completely assembled in one piece without joints, where possible. If dimensions exceed maximum manufactured panel size, provide two or more pieces of equal length as acceptable to Architect. When overall dimensions require delivery in separate units, prefit components at the factory, disassemble for delivery, and make final joints at the site.
- B. Store visual display surfaces vertically with packing materials between each unit.

## **1.10 FIELD CONDITIONS**

- A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Verify actual dimensions of construction contiguous with visual display surfaces by field measurements before fabrication.
  - 1. Allow for trimming and fitting where taking field measurements before fabrication might delay the Work.

## **1.11 WARRANTY**

- A. Special Warranty for Porcelain-Enamel Face Sheets: Manufacturer agrees to repair or replace porcelain-enamel face sheets that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:

- a. Surfaces lose original writing and erasing qualities.
- b. Surfaces exhibit crazing, cracking, or flaking.
- 2. Warranty Period: 50 years from date of Substantial Completion.
- 3. Warranty Period: Life of the building.

B. Warranty for Glass Writing Boards:

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Porcelain-Enamel Face Sheet: Porcelain-enamel-clad, ASTM A 463/A 463M, Type 1, stretcher-leveled aluminized steel, with 0.024-inch uncoated thickness; with porcelain-enamel coating fused to steel at approximately 1000 deg F.
  - 1. Matte Finish: Low reflective; chalk wipes clean with dry cloth or standard eraser.
    - a. Basis of Design:
      - 1) Claridge Products and Equipment, Inc.; Vitracite Chalkboard.
      - 2) Or approved equivalent.
- B. Natural-Cork Sheet: Seamless, single-layer, compressed fine-grain cork sheet; bulletin board quality; face sanded for natural finish.
- C. Hardboard: ANSI A135.4, tempered.
- D. Particleboard: ANSI A208.1, Grade M-1.
- E. MDF: ANSI A208.2, Grade 130.
- F. Fiberboard: ASTM C208 cellulosic fiber insulating board.
- G. Clear Tempered Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering.
- H. Extruded Aluminum: ASTM B221, Alloy 6063.
- I. Adhesives for Field Application: Mildew-resistant, nonstaining adhesive for use with specific type of panels, sheets, or assemblies; and for substrate application; as recommended in writing by visual display unit manufacturer.

### **2.2 GENERAL FINISH REQUIREMENTS**

- A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

### **2.3 ALUMINUM FINISHES**

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
- B. Powder-Coat Finish: AAMA 2603, except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

## 2.4 MARKERBOARDS

- A. Porcelain-Enamel Markerboards: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction consisting of backing sheet, core material, and 0.021-inch-thick, porcelain-enamel face sheet with low-gloss finish.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Claridge Products and Equipment, Inc., or approved equivalent.
  2. Particleboard Core: 7/16 inch thick; with 0.005-inch- thick, aluminum foil backing.
  3. Laminating Adhesive: Manufacturer's standard, moisture-resistant thermoplastic type.
  4. Wall Panel Configuration: Provide continuous wall-covering configurations with matched butt joints, joined with concealed steel splines to ensure alignment of adjacent panels. Provide perimeter trim of entire markerboard area only, as selected by architect.
  5. Markerboard: Porcelain-enamel markerboard assembly.
    - a. Color: As selected by Architect from full range of industry colors.
  6. Corners: Square.
  7. Width: As indicated on Drawings
  8. Height: 4 feet unless indicated otherwise in Drawings.
  9. Mounting: Wall.
  10. Mounting Height: Mount 36 inches above finished floor to top of chalk tray, unless indicated otherwise in Drawings.
  11. Field-Applied Aluminum Trim: Manufacturer's standard, narrow face trim with powder coat finish.
  12. Accessories:
    - a. Chalktray: Solid box type.

## 2.5 GLASS WRITING BOARDS

- A. Basis of Design: Provide 'Float' glass writing boards from Clarus, or approved equivalent.
1. ¼" Clarus tempered safety writing glass.
  2. Opti-Clear polish and eased corners.
  3. Non-magnetic finish.
  4. Concealed mounting hardware.
  5. Accessories: Box tray.
  6. Sizes: As indicated on Drawings.
  7. Colors: to be selected from manufacturer's full range; two colors will be used.

## 2.6 CORK TACKBOARDS

- A. Basis of Design: Cork Bulletin Board by Forbo Flooring Systems, Hazleton, PA, or approved equivalent.
1. Material: Cork board made of linseed oil, cork, rosin binders and dry pigments. The uni-color extends throughout the thickness of the material.
  2. Gauge: ¼".
  3. Backing: Jute.
  4. Width: 48" and 72" (not all colors).
  5. Application: Frameless; Adhered to wall surface.
  6. Fire Testing: Class B when tested in accordance to ASTM E 84 / NFPA 255, Standard Test Method for Surface Burning Characteristics.
  7. Warranty: Limited 5 year.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
- B. Examine walls and partitions for proper preparation and backing for visual display surfaces.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances, such as dirt, mold, and mildew, that could impair the performance of and affect the smooth, finished surfaces of visual display boards.
- C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display units and wall surfaces.
  - 1. Prime and paint wall surfaces prior to adhering cork tackboards or hanging markerboards or glass writing boards.

### **3.3 INSTALLATION**

- A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
- B. Field-Assembled Markerboards: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.
  - 1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, as indicated on approved Shop Drawings.
  - 2. Provide manufacturer's standard vertical-joint spline system between abutting sections of chalkboards or markerboards.
  - 3. Where size of visual display boards or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated.
- C. Glass Writing Boards:
  - 1. Mount glass writing board to wall using manufacturer's concealed mounting hardware and anchors.
- D. Cork Bulletin Board Panels:
  - 1. Follow manufacturer's instructions for direct adherence to wall surface.
  - 2. Areas to receive material should be clean, fully enclosed and weathertight. The permanent HVAC must be fully operational, controlled and set at a minimum of 68°F (20°C) for a minimum of seven days prior to, during, and seven days after the installation. The material (including adhesive) should be conditioned in the same manner for a minimum of 48 hours prior to the installation. Areas to receive material shall be adequately lighted to allow for proper inspection of the substrate, installation and seaming and for final inspection.



3. The substrate shall be sound, smooth, flat, permanently dry, clean and free of all foreign materials including, but not limited to, dust, grease, oils, solvents, old adhesive residue, or any contaminant that could interfere with a secure bond.
4. Use Forbo L 910W adhesive.
  - a. Use a 1/8" x 1/8" x 1/16" V notch trowel.
  - b. Spread Rate: Approximately 90 square feet/gallon.

### **3.4 CLEANING AND PROTECTION**

- A. Clean visual display units in accordance with manufacturer's written instructions. Attach one removable cleaning instructions label to visual display unit in each room.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display units after installation and cleaning.
- D. Protect laminated glazing in accordance with GANA Glazing Manual.
- E. Clean laminated glazing material in accordance with GANA Bulletin 01-0300.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  1. Aluminum
  2. Glass.
  3. Plastic Materials
  4. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 10 11 00**

## **SECTION 10 14 23 - PANEL SIGNAGE**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Interior non-illuminated, directional, code and base building signage.
- B. Related Requirements:
  - 1. Division 14 Section "Machine Room-Less Elevators" for code-required conveying equipment signage.
  - 2. For labels, tags, and nameplates for plumbing piping and equipment, HVAC piping and equipment, and electrical systems and equipment, refer to the drawings.
  - 3. For emergency and exit lighting signs, refer to the drawings.

#### **1.3 COORDINATION**

- A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.
- B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For panel signs.
  - 1. Indicate materials, sizes, configurations and applicable substrate mountings.
  - 2. Include fabrication and installation details and attachments to other work.
  - 3. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
  - 4. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
    - a. A message schedule is to be provided to the Owner for their review and approval prior to any fabrication.
- C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
  - 1. Include representative Samples of available typestyles and graphic symbols.
- D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
  - 1. Full size samples for specific sign types in colors specified.
- E. Product Schedule: For panel signs. Use same designations indicated on Drawings or specified.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer and manufacturer.

- B. Sample Warranty: For special warranty.

## **1.6 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For signs to include in maintenance manuals.

## **1.7 QUALITY ASSURANCE**

- A. Manufacturer qualifications: Work under this section from manufacturers regularly engaged in work of this magnitude and scope for minimum of ten years.
- B. Installer must be regularly engaged in similar work for minimum of five years.
- C. All work shall conform to applicable codes.

## **1.8 FIELD CONDITIONS**

- A. Field Measurements: Verify locations of anchorage devices embedded in permanent construction by other installers by field measurements before fabrication and indicate measurements on Shop Drawings.
  - 1. Where sizes of signs are determined by dimensions of surfaces on which they are installed, verify dimensions by field measurement before fabrication and indicate measurements on Shop Drawings.

## **1.9 DELIVERY, STORAGE AND HANDLING**

Sign contractor to store all signs in a secured area, out of weather and protected, during installation.

## **1.10 SEQUENCING AND SCHEDULING**

- A. Schedule system installation after related finishes have been completed, and in schedule with the project phased construction.

## **1.11 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Deterioration of finishes beyond normal weathering.
    - b. Deterioration of embedded graphic image.
    - c. Separation or delamination of sheet materials and components.
  - 2. Warranty Period: Five years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. General: Provide signs that comply with requirements indicated for materials, thicknesses, finishes, colors, designs, shapes, sizes, and details of construction.
- B. Regulatory Requirements: Comply with all federal, state and local laws, ordinances, and regulations related to signs and ADAAG – Americans with Disabilities Act Accessibility Guidelines as issued by US Architectural and Transportation Barriers Compliance Board.

## 2.2 ADA and SUBSURFACE PLAQUE CONSTRUCTION

- A. Tactile copy and Grade II Braille are to be a minimum of .032". All plaque edges to be clean, smooth, and free of all saw and tooth marks and painted to match the background color of the sign.
- B. Manufacturer's standard acrylic tactile plaque sign construction to meet relevant ADA requirements indicated for materials, thickness, finish, colors, designs, shapes, sizes and details of construction.
- C. Subsurface reverse screened acrylic sign components, consisting of .080 matte acrylic panels laminated to clear acrylic back plate. All panel edges to be clean and smooth, free of any tooling marks. All symbols and letter forms are to faithfully reproduce specified letter, alpha/numeric and symbol forms.
- D. Material to have a Class A Fire Rating and not emit VOC's or formaldehyde.
  - 1. Flame Spread Index.....(20)
  - 2. Smoke developed Index....(110)
- E. Plaque sign mounts with 3M 1/32" double-sided VHB tape.

## 2.3 ACRYLIC SIGNS

- A. Acrylic Panel Room Identification Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
- B. Room ID Sign:
  - 1. Acrylic Plaque with Tactile Graphics and Braille.
    - a. 3/8" thick surface painted acrylic plaque with raised copy.
  - 2. Required at all locations identified in Signage Schedule as Type 1.
  - 3. Surface-Applied Graphics: Silkscreened.
  - 4. Subsurface Graphics: Not required.
  - 5. Color(s): As selected by Architect from manufacturer's full range (total of 2 plaque and graphics color combinations required).
    - a. Provide Pantone Matching System (PMS) colored coatings, including inks and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are non-fading for application intended.
  - 6. Size: As shown in Drawings.
- C. Office ID Sign:
  - 1. Acrylic Plaque with Tactile Graphics, Braille and Acrylic Insert Holder.
  - 2. Required at all locations identified in Signage Schedule as Type 2.
  - 3. Multiple component construction, consisting of:
    - a. 3/8" thick surface painted acrylic plaque with raised copy (built up from surface of window 1/8")
    - b. 1/16" thick clear acrylic face, surface painted (area of window to remain clear) over 3/16" thick acrylic backer, painted edges same color as acrylic face,
  - 4. Surface-Applied Graphics: Silkscreened.
  - 5. Subsurface-Applied Graphics: Not required.
  - 6. Color(s): As selected by Architect from manufacturer's full range (total of 2 required).
    - a. Provide Pantone Matching System (PMS) colored coatings, including inks and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are non-fading for application intended.
  - 7. Size: As shown in Drawings.
- D. Pictogram Sign:
  - 1. Acrylic Plaque with Tactile Graphics, Braille and Pictogram:

- a. 3/8" thick surface painted acrylic plaque with raised copy and pictogram.
  2. Required at all locations identified in Signage Schedule as Type 3 (Restroom), Type 4 (Exit Stair), Type 5 (Elevator Fire), Type 7 (Elevator Two-Way Communication) and Type 12 (Egress Map).
  3. Surface-Applied Graphics: Silkscreened.
  4. Subsurface-Applied Graphics: Not required.
  5. Color(s): As selected by Architect from manufacturer's full range (total of 2 required).
    - a. Provide Pantone Matching System (PMS) colored coatings, including inks and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are non-fading for application intended.
  6. Size: As shown in Drawings.
- E. Exit / Occupancy Signs:
1. Acrylic Plaque with Tactile Graphics and Braille:
    - a. 3/16" thick surface painted acrylic plaque with raised copy.
  2. Required at all locations identified in Signage Schedule as Type 6 (Interior Stair Identification), Type 8 (Max Occupancy), Type 9 (Door Exit) and Type 13 (Interior Stair Floor Level)
  3. Surface-Applied Graphics: Silkscreened.
  4. Subsurface-Applied Graphics: Not required.
  5. Color(s): As selected by Architect from manufacturer's full range (total of 2 required).
    - a. Provide Pantone Matching System (PMS) colored coatings, including inks and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are non-fading for application intended.
  6. Size: As shown in Drawings.

## 2.4 ALUMINUM SIGNS

- A. Aluminum Panel Room Identification Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; with finishes as described in "General Finish Requirements" and "Aluminum Finishes" Subparagraphs below; and as follows:
- B. Aluminum Mullion Sign, Interior:
1. Aluminum Plaque with Tactile Graphics and Braille: Aluminum sheet with raised graphics and Braille.
    - a. Required at all locations identified in Signage Schedule as Type 10 (Door Exit).
    - b. Thickness: 1/8 inch.
    - c. Finish: Baked-Enamel or Powder-Coat Finish.
    - d. Signage Panel Perimeter: Finish edges smooth.
      - 1) Edge Condition, Vertical Edges, Horizontal Edges: Square cut.
      - 2) Corner Condition in Elevation: Square.
    - e. Frame: None.
    - f. Mounting: See Drawings.
    - g. Text and Typeface: Accessible raised characters and Braille with typeface as selected by Architect from manufacturer's full range and variable content as scheduled. Finish raised characters to contrast with background color, and finish Braille to match background color. Raised character color to be selected from manufacturer's full range.
    - h. Flatness Tolerance: Sign panel shall remain flat or uniformly curved under installed conditions as indicated and within a tolerance of plus or minus 1/32 inch measured diagonally from corner to corner.
    - i. Size: As shown in Drawings.
- C. Aluminum Mullion Sign, Exterior:
1. Aluminum Plaque with Tactile Graphics and Braille: Aluminum sheet with raised graphics and Braille.

- a. Required at all locations identified in Signage Schedule as Type 11 (Roof Mounted PV Panel).
- b. Thickness: 1/8 inch.
- c. Finish: Baked-Enamel or Powder-Coat Finish.
- d. Signage Panel Perimeter: Finish edges smooth.
  - 1) Edge Condition, Vertical Edges, Horizontal Edges: Square cut.
  - 2) Corner Condition in Elevation: Square.
- e. Frame: None.
- f. Mounting: See Drawings.
- g. Text and Typeface: Accessible raised characters and Braille with typeface as selected by Architect from manufacturer's full range and variable content as scheduled. Finish raised characters to contrast with background color, and finish Braille to match background color. Raised character color to be selected from manufacturer's full range.
- h. Flatness Tolerance: Sign panel shall remain flat or uniformly curved under installed conditions as indicated and within a tolerance of plus or minus 1/32 inch measured diagonally from corner to corner.
- i. Size: As shown in Drawings.

## 2.5 PANEL-SIGN MATERIALS

- A. Aluminum Sheet and Plate: ASTM B209, alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
- B. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).
- C. Polycarbonate Sheet: ASTM C1349, Appendix X1, Type II (coated, mar-resistant, UV-stabilized polycarbonate), with coating on both sides.
- D. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

## 2.6 ACCESSORIES

- A. Fasteners and Anchors:
  - 1. Exposed Metal-Fastener Components, General:
    - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
    - b. Fastener Heads: For nonstructural connections, use flathead countersunk square drive screws and bolts unless otherwise indicated.
- B. Adhesive: As recommended by sign manufacturer.
  - 1. Adhesives shall have a VOC content of 70 g/L or less.
- C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

## 2.7 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
- B. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for

reassembly and installation; apply markings in locations concealed from view after final assembly.

- C. Signs with Changeable Message Capability: Fabricate signs to allow insertion of changeable messages as follows:
  - 1. For slide-in changeable inserts, fabricate slot without burrs or constrictions that inhibit function. Furnish initial changeable insert. Furnish two blank inserts for each sign for Owner's use.
- D. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.
  - 1. Aluminum Brackets: Factory finish brackets with baked-enamel or powder-coat finish to match sign-background color unless otherwise indicated.

## **2.8 GENERAL FINISH REQUIREMENTS**

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.

## **2.9 ALUMINUM FINISHES**

- A. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.
- C. Verify that anchorage devices embedded in permanent construction are correctly sized and located to accommodate signs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
  - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
  - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
  - 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.

- B. Room Identification Signs and Other Accessible Signage: Install in locations on walls according to accessibility standard and on walls adjacent to latch or hinge side of door per architect's direction during pre-installation conference. Where not possible, such as at double doors, install signs on nearest Architect-approved adjacent wall. Locate to allow approach within 3 inches of sign without encountering protruding objects or standing within swing of door.
- C. Mounting Methods:
  - 1. Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position so that signage is correctly located and aligned.
  - 2. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
  - 3. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position and push to engage tape adhesive.
- D. Mounting Requirements:
  - 1. Where required, anchor holes or penetrations for sign installation should only be made into gypsum wall board. Anchor holes or penetrations should not be made into other wall finishes including but not limited to wood panels, metal panels, slate cladding, and stone masonry.
    - a. Consult Architect prior to proceeding if any sign must be mounted on a surface other than gypsum wall board or glass.
- E. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.

### **3.3 ADJUSTING AND CLEANING**

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed as long as nearby construction activities do not pose a risk of damage to the sign. If nearby construction activities may damage the previously installed signs, protective coverings and strippable films should be left in place until such time as the nearby construction activities have completed and then be removed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

### **3.4 SIGN SCHEDULE**

- A. See Signage Schedule and Signage plans in Drawings for location of specific sign types.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.



- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.
  
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.
  
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 10 14 23**

## **SECTION 10 28 00 - TOILET ACCESSORIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Public-use washroom accessories.
  - 2. Warm-air dryers.
  - 3. Childcare accessories.
  - 4. Custodial accessories.
- B. Related Requirements:
  - 1. Division 9 Section "Ceramic Tiling" for ceramic toilet and bath accessories.
  - 2. Division 22 Section "Commercial Plumbing Fixtures" and schedule on plumbing drawings for underlavatory guard (vitreous china shroud).

#### **1.3 COORDINATION**

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
  - 3. Include electrical characteristics.
- B. Samples: Full size, for each exposed product and for each finish specified.
  - 1. Approved full-size Samples will be returned and may be used in the Work.
- C. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
  - 1. Identify locations using room designations indicated.
  - 2. Identify accessories using designations indicated.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Sample Warranty: For manufacturer's special warranty.

#### **1.6 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For accessories to include in maintenance manuals.

## **1.7 MOCKUP**

- A. Install all toilet accessories in Toilet Room 105 as a mockup for approval before proceeding with remainder of work.

## **1.8 WARRANTY**

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, visible silver spoilage defects.
  - 2. Warranty Period: 15 years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 OWNER-FURNISHED MATERIALS**

- A. Owner-Furnished Materials: Cleaning Chemical Dispenser.

### **2.2 PERFORMANCE REQUIREMENTS**

- A. 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.

### **2.3 PUBLIC-USE WASHROOM ACCESSORIES**

- A. Basis of Design: Provide the following products, or approved equivalent.
- B. Toilet Tissue (Roll) Dispenser:
  - 1. Royce Rolls Standard Toilet Paper Dispenser #TP-4, or approved equivalent.
  - 2. 1 per toilet room
- C. Waste Receptacle:
  - 1. Trim Line Series Recessed Waste Receptacle #B-35643, or approved equivalent.
  - 2. Stainless Steel
  - 3. 1 per toilet room
- D. Liquid-Soap Dispenser:
  - 1. Proline Stainless Steel dispenser by Deb Group, or approved equivalent.
  - 2. 1 per toilet room
  - 3. With each Soap Dispenser, provide Bradley model 9014-63 satin finish stainless steel surface mounted soap dish without drain holes.
    - a. Mount below soap dispenser.
- E. Grab Bar:
  - 1. Mounting: Flanges with concealed fasteners.
  - 2. Material: Stainless steel, 0.05 inch thick.
    - a. Finish: Smooth, No. 4 finish (satin).
  - 3. Outside Diameter: 1-1/4 inches.
  - 4. Configuration and Length: As indicated on Drawings.
- F. Mirror Unit:
  - 1. Frame: Stainless-steel angle, 0.05 inch thick Stainless steel, fixed tilt Stainless steel, adjustable tilt.
    - a. Corners: Welded and ground smooth.
  - 2. Hangers: Produce rigid, tamper- and theft-resistant installation, using method indicated below.
    - a. One-piece, galvanized-steel, wall-hanger device with spring-action locking mechanism to hold mirror unit in position with no exposed screws or bolts.

- b. Wall bracket of galvanized steel, equipped with concealed locking devices requiring a special tool to remove.
- 3. Size: 24" wide x 36" high.
- 4. 1 per toilet room.

G. Coat Hook:

- 1. See Division 08 Section "Door Hardware."
- 2. Coat Hook mounted on back of door in each toilet room.

**2.4 WARM-AIR DRYERS**

A. Source Limitations: Obtain warm-air dryers from single source from single manufacturer.

B. Warm-Air Dryer:

- 1. World Dryer VERDEdri #Q-973A, or approved equivalent.
- 2. Stainless Steel
- 3. 1 per toilet room
- 4. 1 per janitor closet

**2.5 CHILDCARE ACCESSORIES**

A. Diaper-Changing Station:

- 1. Koala Kare Stainless Steel Clad Horizontal Baby Changing Station Wall Recess Mounted #KB110-SSRE, or approved equivalent.
- 2. Total of 2 in project

**2.6 UNDERLAVATORY GUARDS**

A. Underlavatory Guard:

- 1. Description: Insulating pipe covering for supply and drain piping assemblies that prevents direct contact with and burns from piping; allow service access without removing coverings.
- 2. Material: Vitreous china shroud – Kohler K-2057, purchased with lavatory. See Plumbing schedule.

**2.7 CUSTODIAL ACCESSORIES**

A. Source Limitations: Obtain custodial accessories from single source from single manufacturer.

B. Utility Shelf:

- 1. Description: With exposed edges turned down not less than 1/2 inch and supported by two triangular brackets welded to shelf underside.
- 2. Size: 16 inches long by 6 inches deep.
- 3. Material and Finish: Not less than nominal 0.05-inch-thick stainless steel, No. 4 finish (satin).

C. Mop and Broom Holder:

- 1. Mop/Broom Holders: Three, spring-loaded, rubber hat, cam type.
- 2. Material and Finish: Stainless steel, No. 4 finish (satin).

D. Liquid-Soap Dispenser.

- 1. Proline Stainless Steel dispenser by Deb Group, or approved equivalent.
- 2. 1 per janitor closet
- 3. With each Soap Dispenser, provide Bradley model 9014-63 satin finish stainless steel surface mounted soap dish without drain holes.
  - a. Mount below soap dispenser.

## **2.8 MATERIALS**

- A. Stainless Steel: ASTM A666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.
- B. Steel Sheet: ASTM A1008/A1008M, Designation CS (cold rolled, commercial steel), 0.036-inch minimum nominal thickness.
- C. Galvanized-Steel Sheet: ASTM A653/A653M, with G60 hot-dip zinc coating.
- D. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.
- E. Fasteners: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant where exposed, and of galvanized steel where concealed.
- F. Chrome Plating: ASTM B456, Service Condition Number SC 2 (moderate service).
- G. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

## **2.9 FABRICATION**

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

## **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.
- B. Grab Bars: Install to withstand a downward load of at least 250 lbf, when tested according to ASTM F446.

### **3.2 ADJUSTING AND CLEANING**

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written instructions.

### **3.3 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.

- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 10 28 00**

## **SECTION 10 44 13 - FIRE PROTECTION CABINETS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Fire-protection cabinets for the following:
    - a. Portable fire extinguisher.
- B. Related Requirements:
  - 1. Division 10 Section "Fire Extinguishers."

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Show door hardware, cabinet type, trim style, and panel style.
  - 2. Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction.
- B. Shop Drawings: For fire-protection cabinets.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each type of exposed finish required.
- D. Samples for Initial Selection: For each type of exposed finish required.
- E. Samples for Verification: For each type of exposed finish required, prepared on samples 6 by 6 inches square.
- F. Product Schedule: For fire extinguisher cabinets. Coordinate final fire-protection cabinet schedule with fire-extinguisher schedule to ensure proper fit and function.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For fire-protection cabinets to include in maintenance manuals.

#### **1.5 COORDINATION**

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

### **PART 2 - PRODUCTS**

#### **2.1 PERFORMANCE REQUIREMENTS**

- A. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

- B. 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.

## **2.2 FIRE-PROTECTION CABINET**

- A. Cabinet Type: Suitable for fire extinguisher.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. J. L. Industries, Inc., a division of Activar Construction Products Group.
    - b. Kidde Residential and Commercial Division, Subsidiary of Kidde plc.
    - c. Larsen's Manufacturing Company.
    - d. Potter Roemer LLC; (Basis of Design: 7000 Series.)
- B. Cabinet Construction: Nonrated and 1-hour fire rated.
  - 1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.043-inch- (1.09-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: Cold-rolled steel sheet.
- D. Trimless Recessed Cabinet: Cabinet box fully recessed in walls of sufficient depth and installed without trim.
  - 1. Trimless: One-piece combination trim and perimeter door frame flush with surrounding wall surface.
  - 2. Location: Where indicated on drawings.
  - 3. Quantity: One at each location indicated on drawings.
  - 4. Basis of Design Product: 7000 Series Trimless "Alta" series fire extinguisher cabinet as manufactured by Potter Roemer, or approved equivalent.
- E. Cabinet Door and Frame Material: Cold-rolled sheet steel.
- F. Door Style: Fully glazed panel with frame.
- G. Door Glazing: Safety glass.
  - 1. Clear Tempered Safety Glass.
- H. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
  - 1. Provide lever handle and cam latch.
  - 2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.

## **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.
  - 1. Weld joints and grind smooth.
  - 2. Provide factory-drilled mounting holes.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
  - 1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
  - 2. Miter and weld perimeter door frames and grind smooth.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.



## **2.4 GENERAL FINISH REQUIREMENTS**

- A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## **2.5 STEEL FINISHES**

- A. Surface Preparation: Remove mill scale and rust, if present, from uncoated steel. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
- B. Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.
  - 1. Color and Gloss: Custom color and gloss to match wall paint selected by Architect.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine walls and partitions for suitable framing depth and blocking where cabinets will be installed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Prepare recesses for trimless fire-protection cabinets as required by type and size of cabinet and trim style.

### **3.3 INSTALLATION**

- A. General: Install fire-protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
- B. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
  - 1. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.

### **3.4 ADJUSTING AND CLEANING**

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.

- D. Touch up marred finishes or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.
- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 10 44 13**

## **SECTION 10 44 16 - FIRE EXTINGUISHERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.
- B. Related Requirements:
  - 1. Division 10 Section "Fire Protection Cabinets."

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
- B. Product Schedule: For fire extinguishers. Coordinate final fire-extinguisher schedule with fire-protection cabinet schedule to ensure proper fit and function.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Warranty: Sample of special warranty.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.

#### **1.6 COORDINATION**

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

#### **1.7 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 PERFORMANCE REQUIREMENTS**

- A. 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.
  - 1. Provide fire extinguishers approved, listed, and labeled by FM Global.

## **2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS**

- A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
  - 1. Basis-of-Design: Provide Ansul Sentry Stored Pressure Dry Chemical Extinguishers, or approved equivalent.
  - 2. Valves: Manufacturer's standard.
  - 3. Handles and Levers: Manufacturer's standard.
  - 4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging, if required by owner.
  
- B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb (4.5-kg) nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

## **2.3 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 baked-enamel finish.
  - 1. Source Limitations: Obtain mounting brackets and fire extinguishers from single source from single manufacturer.
  
- 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.
  - 2. Mounting brackets to be provided for fire extinguishers in the following locations – all others to be installed in cabinets.
    - a. Rooms 109, 110, 119, 214, 214A (two in this room), 214B, 416, 416A.
    - b. Locate near the doorway into each room.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine fire extinguishers for proper charging and tagging.
  - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
  
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
  
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

### **3.3 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.

- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
1. Aluminum
  2. Plastic Materials and Gaskets
  3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 10 44 16**

## **SECTION 11 13 13 - LOADING DOCK BUMPERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes loading dock bumpers.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of loading dock bumper.
- B. Shop Drawings: For dock bumpers. Include plans, elevations, sections, and attachment details.

### **PART 2 - PRODUCTS**

#### **2.1 LOADING DOCK BUMPERS**

- A. General: Surface-mounted bumpers; of type, size, and construction indicated; designed to absorb kinetic energy and minimize damage to loading dock structure.
  - 1. Source Limitations: Obtain from single source from single manufacturer.
- B. Laminated-Tread Loading Dock Bumper: Fabricated from multiple, uniformly thick plies cut from fabric-reinforced rubber tires. Laminate plies under pressure on not less than two 3/4-inch-diameter, steel supporting rods that are welded at one end to 1/4-inch-thick, structural-steel end angle and secured with a nut and angle at the other end. Fabricate angles with predrilled anchor holes and sized to provide not less than 1 inch of tread plies extending beyond the face of closure angles.
  - 1. Thickness: 4-1/2 inches.
  - 2. Horizontal Style: 10 inches high by.
- C. Anchorage Devices: Galvanized-steel anchor bolts, nuts, washers, bolts, sleeves, cast-in-place plates, and other anchorage devices as required to fasten bumpers securely in place and to suit installation type indicated. Hot-dip galvanized according to ASTM A153/A153M or ASTM F2329/F2329M.
- D. Materials: ASTM A36/A36M for steel plates, shapes, and bars. Hot-dip galvanize according to ASTM A123/A123M.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION, GENERAL**

- A. Loading Dock Bumpers: Attach loading 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.

### **3.3 ADJUSTING**

- A. After completing installation of exposed, factory-finished dock bumpers, inspect exposed finishes and repair damaged finishes.

### **3.4 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 11 13 13**

## **11 51 23 – MOBILE & FIXED LIBRARY STACK SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following types of library stack shelving systems:
  1. Mobile, steel bracket.
  2. Fixed, steel bracket.
  3. Mobile, steel four-post.
  4. Fixed, steel four-post.
  5. Re-erection and installation of salvaged fixed shelving units with new end panels.
  6. Installation of salvaged adjustable shelves in new shelving systems.
  7. Custom-fabricated end panels, canopy tops and countertops which are custom fabricated in the scope of work in Division 06 Section "Interior Architectural Woodwork" are to be installed as part of this Section.
  8. Welded Metal Lockers.
- B. Related Sections include the following:
  1. Division 03 Section "Cast-in-Place Concrete" for topping slab infill between mobile shelving rails.
  2. Division 06 Section "Interior Architectural Woodwork" for fabrication of custom-fabricated end panels, canopy tops, and countertops to be attached to fixed library stack systems which are listed in this Section.
  3. Division 11 Section "Library Equipment" for library equipment.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Provide library stack systems capable of withstanding the effects of earthquake motions determined according to requirements indicated on Structural Drawings.
- B. Mobile and Fixed Library Stack Shelving Systems shall be designed to comply with seismic requirements in a way that maximizes pass-through at double faced units.
- C. Mobile and Fixed Library Stack Shelving Systems shall be designed to comply with codes employing anchorage and rail design which resists tipping without the use of overhead bracing between adjacent ranges.

#### **1.4 SUBMITTALS**

- A. Manufacturer's Product Certification: Submit at time of bid certification as described in Quality Assurance. Submit manufacturer's certification that products comply with requirements of the specifications. A list of deviations must be provided for all items not meeting the specifications. The document must include appropriate justification of the alternate proposed design.
- B. Compatibility with Salvaged Material: Submit at time of bid a letter from manufacturer stating that Owner's salvaged adjustable shelf units are compatible with manufacturer's shelving system. If Owner's salvaged shelf units are not compatible with manufacturer's shelving system, submit documentation to confirm that new shelving units are included in the base bid.
- C. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for library stack systems and accessories specified.



1. Submit installed weight, floor deflection and load criteria, furnished specialties and accessories. Include rated capacities.
- D. Shop Drawings: Prepared by or under the supervision of a qualified professional engineer detailing fabrication, assembly and installation of fixed and mobile storage units, as well as procedures and diagrams.
1. Include details of layout and installation including clearances, spacings, and relation to adjacent construction in plan, elevation, and section; clear exit and access aisle widths; access to concealed components; components, assemblies, connections, attachments, reinforcement, and anchorage; and deck details, edge conditions and finish flooring.
  2. Actual dimensional requirements for custom millwork accessories to be fabricated by others and installed as part of this Section.
  3. Rail details which indicate actual dimensions of structural floor, topping slab and floor finish required for each condition in the project.
  4. Show fabrication and installation details for library stack systems and methods of anchoring to building structure. Include clear aisle widths from face of units.
  5. Layouts shall dimension the clearances required between stack systems and partitions to allow for adequate mechanical circulation, as indicated in contract documents.
  6. Plans, elevations, section and details of welded metal lockers.
- E. Embedment Coordination Drawings: Dimensioned locations for all materials embedded in concrete. All devices shall be aligned and located in accordance with architectural reflected ceiling plans. Show all materials embedded in cast-in-place concrete, including but not limited to:
1. Conduit, floor boxes and ceiling junction boxes and other raceways serving power, data and security devices.
  2. Conduit, floor boxes and ceiling junction boxes and other raceways serving fire alarm and life safety devices.
  3. Conduit, floor boxes and ceiling junction boxes and other raceways serving lighting and occupancy sensors, daylight photo sensors and other lighting control devices.
  4. Mobile shelving rails and anchors.
  5. Channel strut piping supports which are embedded into or fastened to the underside surface of slabs with post-installed, drop in anchors.
  6. Embedded and suspended fire suppression piping.
  7. Embedded plates and sleeves.
- F. Samples for Initial Selection: For units with factory-applied color finishes.
1. Include samples of shelving components, including end panels and top panels, mobile carriages and accessories involving color selection.
- G. Samples for Verification: For each type of exposed finish required, prepared on
1. Size: **6 inches** square.
- H. Qualification Data: For Installer, signed by manufacturer certifying that installers comply with specified requirements.
- I. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of steel bracket shelving used.
- J. Maintenance Data: Provide mobile and fixed library stack system maintenance manuals.
- K. Warranty: Special warranty specified in this Section.

## **1.5 QUALITY ASSURANCE**

- A. Source Limitations:
1. Obtain each type of shelving system from a single manufacturer.
  2. Obtain all mobile library stack system components from one manufacturer.

- B. **Manufacturer's Product Certifications:** Separate written certifications by manufacturer on manufacturer's letterhead at time of bid required stating compliance with all specifications of shelving systems. Shelving certifications must confirm compliance with all shelf sizes and gauges as noted in these specifications.
- C. **Installer Qualifications:** Engage an experienced installer who is an authorized representative of both the mobile storage unit manufacturer and the shelving unit manufacturer(s). Demonstrate authorization for both installing carriages and anchoring shelving units to carriages required for this project.
- D. **Professional Engineer Qualifications:** A professional engineer who is legally qualified to practice in jurisdiction where the Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of mobile storage units that are similar to those indicated for this project in material, design and extent.
- E. **Listing and Labeling:** Provide mobile storage units specified in this Section that are listed and labeled.
  - 1. The terms "listed" and "labeled" as defined in NFPA 70, article 100.
  - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- F. **Pre-Installation Conference:** Conduct conference at Project site to comply with requirements of Division 1 Section Project Meetings. Review methods and procedures related to mobile storage units, including, but not limited to, the following:
  - 1. Inspect and discuss condition and levelness of flooring and other preparatory work performed under other contracts.
  - 2. Review structural loading limitations.
  - 3. In addition to the Contractor and the installer, arrange for the attendance of the following:
    - a. Contractor installing the topping slab.
    - b. Millwork contractor.
    - c. Other installers affected by the work of this Section.
    - d. The Owner's representative.
    - e. The Architect.
    - f. Manufacturer's representative.
- G. **Product Options:** Drawings indicate size, profiles, and dimensional requirements of library stack systems and are based on the specific system indicated.
  - 1. Do not modify requirements, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- 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. One range of typical steel bracket mobile shelving, type MD1, with salvaged shelves.
  - 2. One range of typical 4 post mobile shelving.
  - 3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.

## **1.6 PROJECT CONDITIONS**

- A. **Field Measurements:** Verify mobile storage unit location by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

## **1.7 WARRANTY**

- A. Submit a written warranty, executed by Contractor, Installer and Manufacturer, agreeing to repair or replace units that fail in materials or workmanship within the specified warranty period. This warranty shall be in addition to, not limitation of other rights the Owner may have against the Contractor under Contract Documents.
- B. All new materials in the fixed and mobile library stack system shall be warranted to be free of defect in materials or workmanship for the life of the product. The manufacturer shall provide, for a period of two years, free of charge, all parts and labor at the location of the fixed and mobile library stack system to repair or replace any part of the product that fails because of such defect.
- C. All Warrantees shall commence from the 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. Return all salvaged, uninstalled adjustable shelves or fixed shelving units to Owner.
  - 2. Paint touchup kit: For each finish.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Steel Sheet: Uncoated, cold-rolled, steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- B. Grout: Non-shrink hydraulic cement grout, 8000 psi after curing.

### **2.2 MOBILE STORAGE UNITS**

- A. Mode of Operation: The system shall be of the mechanical assist type. A drive system is required to provide uniform movement along the total length of the carriages with unbalanced loads on the carriage. The system shall have a positive drive to ensure that there is no play in the drive handle and that the carriage will stop without drifting. All components of the system shall be compatible for smooth, non-jerking, even movement along the total length of the carriage. Mechanical-assist mobile storage units shall consist of a chain and sprocket reduction system, operated by hand.
  - 1. Each movable carriage shall be equipped with manufacturer's standard style disk crank handle.
- B. Rail Design: Carriage and rail system shall be designed and manufactured to carry a minimum load of 1,000 pounds per linear foot of carriage.
  - 1. Rail design shall comply with the requirements of "Structural Support" paragraphs of this Section.
  - 2. Rails shall be steel and compatible with wheel design and carriage loads. Rails shall distribute the concentrated wheel load to a minimum surface area of four square inches where the base of the rail contacts the grout.
  - 3. The rail system shall incorporate smooth contact surfaces for the wheels and wheel guidance system.
  - 4. Rail profile and adjacent recesses shall comply with manufacturer's requirements for carriage guidance system and anti-tip system.
  - 5. Rail shall be located and positioned according to approved shop drawings, leveled and grouted, allowing a minimum of ¼" grout under high point. Any voids below rail shall be completely filled. Shim leveling is not acceptable.

6. Rail shall be designed for installation within dimension allowed by topping slab indicated in structural documents and shall be flush with topping slab.
  7. Rail connections shall be pinned or connected for horizontal and vertical continuity according to manufacturer's recommendations.
  8. Rail shall provide for minimum surface width and profile according to manufacturer's recommendations.
- C. Grout: Grout compound shall be a non-metallic, non-shrink type cement which, when mixed with water, will harden rapidly to produce a permanent foundation for the rails.
1. Grout shall comply with manufacturer's requirements.
  2. Grout compound shall meet ASTM C-1107-91 and CRD C-621.
  3. Grout shall not rust or exhibit any type of corrosion.
- D. Carriage construction: Carriage and rail system shall be designed and manufactured to carry a minimum load of 1,000 pounds per linear foot of carriage.
1. Design of carriage shall maintain proper unit alignment and weight distribution under even and uneven shelf loading.
  2. Carriage construction shall be designed to allow any type of shelving to be securely anchored to the carriage.
  3. Mobile library stack system carriages shall be sized to be structurally and visually compatible with the type and size shelving indicated in this section. Carriage faces shall be flush with face of base shelf.
  4. Carriage straightness shall have no more than 1/4 inch maximum deviation from a true straight line. There shall be no permanent set or slippage in any spliced or welded joint when exposed to the forces encountered in normal operation conditions.
  5. Drive guidance system shall prevent carriage whipping, binding and wheel or rail wear. Systems requiring drive shafts shall be driven with a common straight line axle. Drive shaft and wheel assemblies shall exhibit no play or looseness over the entire length of that assembly. All rotating load bearing members shall ride in precision ball bearings.
  6. All wheels along one side of the carriage of the mechanical assist units shall be driven with one driven wheel per rail.
  7. All mechanical carriages to have at least one drive wheel and one load wheel per rail per carriage.
  8. Drive wheels shall be a minimum of 5 inches in diameter and constructed of solid steel for smooth operation. Minimum load capacity for all wheels, including drive, guide and load wheels shall be as required to meet requirements of anticipated loading.
  9. All wheels and rails to be manufactured from the same grades of steel to prevent uneven wear of any system components.
  10. All carriages are to have the ability of having anti-tip mechanism field installed.
  11. Wheel channel to be formed from a single piece of steel with a minimum thickness of 1/8 inch.
- E. Drive Mechanism:
1. Drive mechanism shall have a gear ratio of one pound of force to 3,000 pounds of load.
  2. All bearings used in the drive mechanism shall be permanently sealed and lubricated.
  3. Drive mechanism shall transfer power to the wheels at a point near the center of the carriage to prevent whipping.
  4. The crank shall connect to the drive through a heavy-duty chain.
  5. All gears shall ride on permanently lubricated bearings.
- F. Mobile storage carriages shall be sized to support shelving in this Section indicated for mobile installation.

### **2.3 STEEL BRACKET SHELVING**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide "Cantilever Shelving Systems" as manufactured by Spacesaver Corporation, Fort Atkinson, WI, or an approved equivalent.

- B. Bookstack design shall allow for either static or mobile installation.
- C. Steel Bracket Library Shelving: Shelving designed for library use and consisting of a complete upright welded frame per section, with adjustable shelves cantilever-hung by brackets on one or both sides of uprights, and complying with ANSI Z39.73.
  - 1. Configuration: Self-supporting units.
  - 2. Bookstack section may be removed as a modular unit from any range without disturbing adjacent units in any way.
  - 3. Welded frame shelving units shall be suitable for either static or mobile installation.
- D. Upright Post Frames: Welded.
  - 1. Upright Posts: Steel channels, 0.060 inch thick, with slots to receive shelf bracket tabs at 1 inch o.c.
  - 2. Seismic Sway Braces.
  - 3. Post dimension: approximately 1 inch by 2 ½ inches.
  - 4. Spreaders: Tube steel, 0.060 inch thick.
  - 5. Reinforcing Gusset Plates: Triangular plates; 0.060-inch- thick, cold-rolled steel, with return flange along bottom edge.
- E. Base Shelves: One-piece shelves, with integral back stops, 0.048-inch- thick, cold-rolled steel, designed to fit snugly around upright columns, with kick plate 3 inches high. Provide flat base shelves typical. Unless otherwise indicated, provide one base shelf for each shelving unit.
  - 1. Base Shelf Brackets: Provide 2 brackets per base shelf; 0.060-inch- thick, cold-rolled steel, with return flange along bottom edge.
- F. Levelers: Provide adjustable pin levelers at carpeted surfaces and adjustable glides elsewhere. Provide number per unit recommended by manufacturer.
- G. Adjustable Steel Shelves: Unless noted otherwise: manufacturer's standard shelves; 0.048-inch- thick, cold-rolled steel.
  - 1. Adjustable Shelving Brackets: Provide 2 brackets per adjustable shelf; 0.060-inch- thick, cold-rolled steel. Brackets shall extend at least 6 inches above shelf surface.
- H. Hinged Periodical Shelving: Pivoting display shelves hinged to shelf brackets which engage in slots in upright. Sloped display shelves shall be 14" actual height with a flange at the bottom and a boxed flange upwards with inside safety hem. Storage shelf shall be 12 inches nominal depth. Brackets shall allow for slope approximately 20 degrees from vertical.
- I. Salvaged Steel Fixed Shelving Units and Adjustable Shelves:
  - 1. Where indicated, install Owner-furnished salvaged fixed single and double-faced shelving units salvaged from existing library.
  - 2. Where indicated, install Owner-furnished salvaged cantilevered shelves salvaged from existing library. If salvaged shelves are not compatible with manufacturer's shelving system, provide new shelves where salvaged are indicated.
- J. End Panels:
  - 1. Steel Panels: Cold-rolled steel sheet, 0.048inch thick, one-piece construction with smooth finish, unless otherwise noted.
  - 2. Refer to architectural details for library stack system substrate preparation required for fastening custom millwork end panels specified in Division 06 Section Architectural Woodwork to fixed library stack systems.
  - 3. Installing custom woodwork end panels, counter tops and canopy tops fabricated by others shall be installed as work of this Section.
- K. Canopy Top / Counter Attachments:
  - 1. Where custom canopy top / counters are indicated, provide manufacturer's standard attachment brackets for counter tops and any other preparation to provide substrate for

fastening custom millwork specified in Division 06 Section Architectural Woodwork to fixed library stack systems.

- L. Back Panels: One-piece panels; 0.048-inch- thick, cold-rolled steel, with smooth finish, sized to completely fill space between uprights of single-faced units for full height of unit. Provide back panels where indicated.
- M. Fillers: Provide corner peninsula and intermediate wall filler panels; 0.048-inch- thick, cold-rolled steel, with fitted caps, in color and finish to match shelving. Locate where indicated to fill gaps at abutting shelving units.
- N. Bookstack Units SS1: Salvaged Single Faced - Typical fixed in staff areas.
  - 1. These are EXISTING units to be reinstalled in the new building.
  - 2. Locations: 303 Circ Desk; 307 Tech Services
  - 3. Mobile or Fixed: Fixed.
  - 4. Type: Single-faced units.
  - 5. Frame Style: Upright post.
  - 6. Width: 36 inches.
  - 7. Height: 90 inches.
  - 8. Number of Shelves: Six adjustable existing shelves; one existing base shelf. (Total 7 high.)
  - 9. Base Shelf Depth: 11 inch actual.
  - 10. Base Shelf Style: flat.
  - 11. Adjustable Shelf Depth: 9 inch actual.
  - 12. Shelf Style: Flat.
  - 13. Shelf and Frame Finish: Existing black paint.
  - 14. NEW End Panels: One steel end panel at each end of each range, at visible ends of ranges behind the Circulation Desk only.
    - a. Height: 90".
    - b. Finish: Custom metallic paint finish.
  - 15. Canopy Top: None.
- O. Bookstack Units SD1: Salvaged Double Faced - Typical fixed at stacks.
  - 1. These are EXISTING units to be reinstalled in the new building.
  - 2. Locations: 225 Stacks
  - 3. Mobile or Fixed: Fixed.
  - 4. Type: Double-faced units.
  - 5. Frame Style: Upright post.
  - 6. Width: 36 inches.
  - 7. Height: 90 inches.
  - 8. Number of Shelves: Twelve adjustable existing shelves; two existing base shelves. (Total 7 high.)
  - 9. Base Shelf Depth: 20 inches actual.
  - 10. Base Shelf Style: flat.
  - 11. Adjustable Shelf Depth: 9 inch actual.
  - 12. Shelf Style: Flat.
  - 13. Shelf and Frame Finish: Existing black paint.
  - 14. NEW End Panels: One steel end panel at each end of each range.
    - a. Height: 90".
    - b. Finish: Custom metallic paint finish.
  - 15. Canopy Top: None.
- P. Bookstack Units SD1-M: Salvaged Double Faced - Typical fixed at stacks within mobile sections.
  - 1. These are EXISTING units to be reinstalled in the new building.
  - 2. Locations: 111 Stacks; 121 Stacks; 225 Stacks; 426 Stacks
  - 3. Mobile or Fixed: Fixed.
  - 4. Type: Double-faced units.

5. Frame Style: Upright post.
6. Width: 36 inches.
7. Height: 90 inches.
8. Number of Shelves: Twelve adjustable existing shelves; two existing base shelves. (Total 7 high.)
9. Base Shelf Depth: 20 inches actual.
10. Base Shelf Style: flat.
11. Adjustable Shelf Depth: 9 inch actual.
12. Shelf Style: Flat.
13. Shelf and Frame Finish: Existing black paint.
14. NEW End Panels: One steel end panel at each end of each range.
  - a. Height: 96".
  - b. Finish: Custom metallic paint finish.
15. Canopy Top: None.

Q. Bookstack Units SD2-M: Salvaged Double Faced - Typical fixed at Reference stacks (L3) within mobile sections.

1. These are EXISTING units to be reinstalled in the new building.
2. Locations: 328 Stacks.
3. Mobile or Fixed: Fixed.
4. Type: Double-faced units.
5. Frame Style: Upright post.
6. Width: 36 inches.
7. Height: 90 inches.
8. Number of Shelves: Ten adjustable existing shelves; two existing base shelves. (Total 6 high.)
9. Base Shelf Depth: 20 inches actual.
10. Base Shelf Style: flat.
11. Adjustable Shelf Depth: 9 inch actual.
12. Shelf Style: Flat.
13. Shelf and Frame Finish: Existing black paint.
14. NEW End Panels: One steel end panel at each end of each range.
  - a. Height: 96".
  - b. Finish: Custom metallic paint finish.
15. Canopy Top: None.

R. Bookstack Units SD3: Salvaged Double Faced - Typical fixed at staff areas.

1. These are EXISTING units to be reinstalled in the new building.
2. Locations: 328 Stacks.
3. Mobile or Fixed: Fixed.
4. Type: Double-faced units.
5. Frame Style: Upright post.
6. Width: 36 inches.
7. Height: 90 inches.
8. Number of Shelves: Twelve adjustable existing shelves; two existing base shelves. (Total 7 high.)
9. Base Shelf Depth: 20 inches actual.
10. Base Shelf Style: flat.
11. Adjustable Shelf Depth: 9 inch actual.
12. Shelf Style: Flat.
13. Shelf and Frame Finish: Existing black paint.
14. NEW End Panels: One steel end panel at each end of each range.
  - a. Height: 90".
  - b. Finish: Custom metallic paint finish.
15. Canopy Top: None.

S. Bookstack Units FD1: NEW Double Faced Oversized in stacks area.

1. Locations: 426 Stacks.

2. Mobile or Fixed: Fixed.
  3. Type: Double-faced units.
  4. Frame Style: Upright post.
  5. Width: 36 inches.
  6. Height: 90 inches.
  7. Number of Shelves: Eight NEW adjustable shelves; two NEW base shelves. (Total 5 high.)
  8. Base Shelf Depth: 24 inches actual.
  9. Base Shelf Style: flat.
  10. Adjustable Shelf Depth: 11 inches actual.
  11. Shelf Style: Flat.
  12. Finish: Standard paint finish; color to be selected by Architect.
  13. NEW End Panels: One steel end panel at each end of each range.
    - a. Height: 90".
    - b. Finish: Custom metallic paint finish.
  14. Canopy Top: None.
- T. Bookstack Units FD2: NEW Double Faced Media (CD / DVD) in stacks area.
1. Locations: 121 Stacks.
  2. Mobile or Fixed: Fixed.
  3. Type: Double-faced units.
  4. Frame Style: Upright post.
  5. Width: 36 inches.
  6. Height: 90 inches.
  7. Number of Shelves: Fourteen NEW adjustable shelves; two NEW base shelves. (Total 8 high.)
  8. Base Shelf Depth: 20 inches actual.
  9. Base Shelf Style: Media shelf, with slotted shelf and shelf back to receive tabbed media dividers.
  10. Adjustable Shelf Depth: 9 inches actual.
  11. Shelf Style: Media shelf, with slotted shelf and shelf back to receive tabbed media dividers.
  12. Finish: Standard paint finish; color to be selected by Architect.
  13. Accessories: Provide four tabbed media dividers per shelf.
  14. NEW End Panels: One steel end panel at each end of each range.
    - a. Height: 96".
    - b. Finish: Custom metallic paint finish.
  15. Canopy Top: None.
- U. Bookstack Units FD3: NEW Double Faced for Bestsellers.
1. Locations: 330A Open Study
  2. Mobile or Fixed: Fixed.
  3. Type: Double-faced units.
  4. Frame Style: Upright Frame
  5. Width: 36 inches.
  6. Height: 42 inches.
  7. Number of Shelves: Four NEW adjustable shelves; two NEW base shelves. (Total 3 high.)
  8. Base Shelf Depth: 26 inches actual.
  9. Base Shelf Style: flat.
  10. Adjustable Shelf Depth: 12 inches actual.
  11. Shelf Style: Flat.
  12. Shelf and frame finish: Black, to match existing shelving.
  13. NEW End Panels: Custom metallic paint finish.
    - a. Height and width as shown on Drawings.
  14. Canopy Top: See Division 06 Section "Interior Architectural Woodwork" and Drawings for custom canopy top materials and details.



- V. Bookstack Units FD4: NEW Double Faced for New Books and Ramapo Authors.
1. Locations: 330A Open Study
  2. Mobile or Fixed: Fixed.
  3. Type: Double-faced units.
  4. Frame Style: Upright Frame
  5. Width: 36 inches.
  6. Height: 42 inches.
  7. Number of Shelves: Four NEW adjustable shelves; two NEW base shelves. (Total 3 high.)
  8. Base Shelf Depth: 26 inches actual.
  9. Base Shelf Style: Sloped.
  10. Adjustable Shelf Depth: 12 inches actual.
  11. Shelf Style: Sloped.
  12. Shelf and frame finish: Black, to match existing shelving.
  13. NEW End Panels: Custom metallic paint finish.
    - a. Height and width as shown on Drawings.
  14. Canopy Top: See Division 06 Section "Interior Architectural Woodwork" and Drawings for custom canopy top materials and details.
- W. Bookstack Units FD5: NEW Double Faced for Browsing Periodicals.
1. Locations: 330A Open Study
  2. Mobile or Fixed: Fixed.
  3. Type: Double-faced units.
  4. Frame Style: Upright Frame
  5. Width: 36 inches.
  6. Height: 42 inches.
  7. Number of Shelves: Four NEW adjustable shelves; two NEW base shelves. (Total 3 high.)
  8. Base Shelf Depth: 26 inches actual.
  9. Shelf Style: Hinged periodical, with storage below.
  10. Adjustable Shelf Depth: 12 inches actual.
  11. Shelf Style: Hinged periodical, with storage below.
  12. Shelf and frame finish: Black, to match existing shelving.
  13. NEW End Panels: Custom metallic paint finish.
    - a. Height and width as shown on Drawings.
  14. Canopy Top: See Division 06 Section "Interior Architectural Woodwork" and Drawings for custom canopy top materials and details.
- X. Bookstack Units FD6: NEW Special Collections Shelving
1. Locations: 217 Closed Stacks
  2. Mobile or Fixed: Fixed.
  3. Type: Double-faced units.
  4. Frame Style: Upright post.
  5. Width: 36 inches.
  6. Height: 96 inches, including carriage.
  7. Number of Shelves: Ten NEW adjustable shelves; two NEW base shelves. (Total 6 high.)
  8. Base Shelf Depth: 32 inches actual.
  9. Base Shelf Style: Flat.
  10. Adjustable Shelf Depth: 15 inches actual.
  11. Shelf Style: Flat.
  12. Finish: Standard paint finish; color to be selected by Architect.
  13. NEW End Panels: One steel end panel at each end of each range.
    - a. Height: 96".
    - b. Finish: Standard paint finish; color to be selected by Architect.
  14. Canopy Top: None.
- Y. Bookstack Units FD7: NEW Special Collections Shelving

1. Locations: 217 Closed Stacks
  2. Mobile or Fixed: Fixed.
  3. Type: Double-faced units.
  4. Frame Style: Upright post.
  5. Width: 36 inches.
  6. Height: 96 inches, including carriage.
  7. Number of Shelves: Ten NEW adjustable shelves; two NEW base shelves. (Total 6 high.)
  8. Base Shelf Depth: 20 inches actual.
  9. Base Shelf Style: Flat.
  10. Adjustable Shelf Depth: 9 inches actual.
  11. Shelf Style: Flat.
  12. Finish: Standard paint finish; color to be selected by Architect.
  13. NEW End Panels: One steel end panel at each end of each range.
    - a. Height: 96".
    - b. Finish: Standard paint finish; color to be selected by Architect.
  14. Canopy Top: None.
- Z. Bookstack Units MD1: NEW Typical Stacks Mobile Shelving.
1. Locations: 111 Stacks; 121 Stacks; 225 Stacks; 426 Stacks
  2. Mobile or Fixed: Mobile.
  3. Type: Double-faced units.
  4. Frame Style: Upright post.
  5. Width: 36 inches.
  6. Height: 96 inches, including carriage.
  7. Number of Shelves: Twelve adjustable shelves; two base shelves. (Total 7 high.)
    - a. Base bid: EXISTING salvaged frame and shelves attached to new mobile carriage; existing black paint finish.
    - b. Alternate: NEW frame and shelves; standard paint finish.
  8. Base Shelf Depth: 20 inches actual.
  9. Base Shelf Style: Flat.
  10. Adjustable Shelf Depth: 9 inches actual.
  11. Shelf Style: Flat.
  12. Finish: Standard paint finish; color to be selected by Architect.
  13. NEW End Panels: One steel end panel at each end of each range.
    - a. Height: 96".
    - b. Finish: Custom metallic paint finish.
  14. Canopy Top: None.
- AA. Bookstack Units MD2: NEW Reference Mobile Shelving.
1. Locations: 328 Stacks
  2. Mobile or Fixed: Mobile.
  3. Type: Double-faced units.
  4. Frame Style: Upright Frame
  5. Width: 36 inches.
  6. Height: 96 inches, including carriage.
  7. Number of Shelves: Ten adjustable shelves; two base shelves. (Total 6 high.)
    - a. Base bid: EXISTING salvaged frame and shelves attached to new mobile carriage; existing black paint finish.
    - b. Alternate: NEW frame and shelves; standard paint finish.
  8. Base Shelf Depth: 20 inches actual.
  9. Base Shelf Style: Flat.
  10. Adjustable Shelf Depth: 9 inches actual.
  11. Shelf Style: Flat.
  12. NEW End Panels: One steel end panel at each end of each range.
    - a. Height: 96".
    - b. Finish: Custom metallic paint finish.
  13. Canopy Top: None.

- BB. Bookstack Units MD3: NEW Mobile Double Faced Media (CD / DVD) in stacks area.
1. Locations: 121 Stacks
  2. Mobile or Fixed: Mobile.
  3. Type: Double-faced units.
  4. Frame Style: Upright Frame
  5. Width: 36 inches.
  6. Height: 96 inches, including carriage.
  7. Number of Shelves: Fourteen NEW adjustable shelves; two NEW base shelves. (Total 8 high.)
  8. Base Shelf Depth: 20 inches actual.
  9. Base Shelf Style: Media shelf, with slotted shelf and shelf back to receive tabbed media dividers.
  10. Adjustable Shelf Depth: 9 inches actual.
  11. Shelf Style: Media shelf, with slotted shelf and shelf back to receive tabbed media dividers.
  12. Finish: Standard paint finish; color to be selected by Architect.
  13. Accessories: Provide four tabbed media dividers per shelf.
  14. NEW End Panels: One steel end panel at each end of each range.
    - a. Height: 96".
    - b. Finish: Custom metallic paint finish.
  15. Canopy Top: None.
- CC. Bookstack Units MD4: NEW Music Score Shelving.
1. Locations: 121 Stacks
  2. Mobile or Fixed: Mobile.
  3. Type: Double-faced units.
  4. Frame Style: Upright post.
  5. Width: 36 inches.
  6. Height: 96 inches, including carriage.
  7. Number of Shelves: Ten NEW adjustable shelves; two NEW base shelves. (Total 6 high.)
  8. Base Shelf Depth: 24 inches actual.
  9. Base Shelf Style: Flat.
  10. Adjustable Shelf Depth: 11 inches actual.
  11. Shelf Style: Flat.
  12. Finish: Standard paint finish; color to be selected by Architect.
  13. NEW End Panels: One steel end panel at each end of each range.
    - a. Height: 96".
    - b. Finish: Custom metallic paint finish.
  14. Canopy Top: None.

## 2.4 STEEL FOUR-POST SHELVING

- A. Basis-of-Design Product: Subject to compliance with requirements, provide "4-Post & Case Type Shelving Systems" as manufactured by Spacesaver Corporation, Fort Atkinson, WI, or an equivalent product.
- B. Bookstack design shall allow for either static or mobile installation.
- C. Steel Four-Post Library Shelving: Shelving designed for library use and consisting of four angle-iron uprights per section, with adjustable shelves resting on shelf supports hung on uprights.
  1. Configuration: Self-supporting units.
- D. Uprights: Double-wall posts formed from 2-inch- wide, 0.048-inch- thick, cold-rolled steel, in manufacturer's standard T-shape for common-post use or L-shape at range ends, with keyhole perforations on the inner wall at 1-1/2 inches o.c.

1. Open Back and Closed Ends: Provide 0.048-inch- thick, steel spacers, 3 inches high, welded to posts at bottom, center, and top to prevent deflection.
- E. Base: Support for bottom shelf; 0.060-inch- thick, steel channel; with kick plate 3 to 4 inches high, and with holes for floor anchors.
- F. Adjustable Steel Shelves: Manufacturer's standard shelves; 0.030-inch- thick, cold-rolled steel.
1. Shelf Supports: Full shelf width supports; 0.075-inch- thick, hot-rolled steel, minimum 3/4 inches high, with flange to support shelf reinforcements, and with ear at each end containing 2 shoulder rivets with 7/16-inch heads spaced to set into keyhole slots on uprights.
  2. Shelf Reinforcements: Channel shapes equal in length to depth of the shelf supported; 0.060-inch- thick, steel channels, with notched ends to fit over inside lip of shelf support.
- G. End Panels:
1. Steel Panels: Cold-rolled steel sheet, 0.048 inch thick, with smooth finish, unless otherwise noted.
- H. Bookstack Units FS1: NEW Archives Shelving, Carton.
1. Locations: 217 Closed Stacks
  2. Mobile or Fixed: Fixed.
  3. Type: Single-faced units.
  4. Width: 36 inches.
  5. Height: 90 inches.
  6. Number of Shelves: Six shelves; five openings.
  7. Shelf Depth: 26 inches actual.
  8. Shelf Style: Flat.
  9. Finish: Standard paint finish; color to be selected by Architect.
  10. Endpanel: One steel end panel at each end of range.
    - a. Height: 96 inches.
    - b. Finish: Standard paint finish.
  11. Top Shelf.
- I. Bookstack Units FS2: NEW Archives Shelving, Newspapers.
1. Locations: 217 Closed Stacks
  2. Mobile or Fixed: Fixed.
  3. Type: Single-faced unit.
  4. Width: 36 inches.
  5. Height: 90 inches.
  6. Number of Shelves: Twelve shelves; eleven openings.
  7. Shelf Depth: 26 inches actual.
  8. Shelf Style: Flat.
  9. Finish: Standard paint finish; color to be selected by Architect.
  10. Endpanel: One steel end panel at each end of range.
    - a. Height: 96 inches.
    - b. Finish: Standard paint finish.
  11. Top Shelf.
- J. Bookstack Units FS3: NEW Folio Shelving, Stacks.
1. Locations: 426 Stacks
  2. Mobile or Fixed: Fixed.
  3. Type: Single-faced units.
  4. Width: 36 inches.
  5. Height: 90 inches.
  6. Number of Shelves: Custom fixed shelves; see drawings.
  7. Shelf Depth: 20 inches actual.
  8. Shelf Style: Flat.
  9. Finish: Standard paint finish; color to be selected by Architect.

10. Endpanel: One steel end panel at each end of range.
  - a. Height: 90 inches.
  - b. Finish: Custom metallic paint finish.
  - c. Width: Custom width to cover ends of art wall behind folio unit.
11. Top Shelf.
12. Back panel: Steel to extend full height.

## **2.5 ACCESSORIES**

- A. Manufacturer's standard prefinished metal range finder card holders, projecting V-shaped to be mounted on end panels.
  1. Provide one projecting card holder at each end of each range.

## **2.6 LOCKERS**

- A. Basis of Design: Provide Day Use Lockers as manufactured by Spacesaver, Inc., or approved equivalent.
  1. Construction: Welded frame and shelves of 18 gauge steel. Doors formed from 2 pieces of minimum 20 gauge cold rolled steel. Doors shall be full overlay style.
  2. Hinges: Full overlay 1" hinges, soft close style. Opens 110 degrees.
  3. Doors to remain closed when in unlock mode.
  4. Finish: Powder coat.
    - a. Custom color to match Architect's sample.
  5. Configuration: See Drawings.
  6. Accessories: Provide 1 coat hook per locker.
  7. Lock Type: Ojmar master keyed, 4 digit combination lock, or approved equivalent.

## **2.7 STRUCTURAL SUPPORT**

- A. Anchorage, shelf framing and rail design shall be designed as a system that resists tipping as required by applicable codes, without the use of overhead bracing between ranges.
- B. Floor Anchorage: Galvanized steel, power-actuated fasteners. Provide number per unit recommended by manufacturer.
  1. Embedment to post-tensioned slabs is limited to three quarters of an inch.
  2. Submit proposed anchorage fasteners and embedment depth for approval by Architect and Structural Engineer.
  3. Anchor shelving units to access flooring in a manner acceptable to access flooring manufacturer.
- C. Wall Anchorage: Manufacturer's standard, powder-coated, galvanized steel anchor designed to secure shelving to adjacent wall. Anchor finish to match finish of shelving. Provide one per shelving unit for each shelving unit adjacent to a wall.
- D. Anti-tip rails: For mobile library stack systems, provide manufacturer's standard C shaped channel at rail as required to prevent shelving from tipping.

## **2.8 FINISHES, GENERAL**

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating metal finishes.
- B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

1. All components of the entire mobile and fixed library stack systems, including those obtained from different manufacturers, shall be free from variations in finish appearance.

## **2.9 STEEL FINISHES**

- A. Baked-Enamel/Powder-Coated Metallic Finish: Immediately after cleaning and pretreating, apply manufacturer's standard baked-on finish. Comply with coating manufacturer's written instructions for applying and baking.
  1. Color and Gloss: Match Architect's sample.
  2. There will be two standard paint colors and one custom metallic paint color required.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine subfloor surfaces, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of mobile storage units and library stack systems.
  1. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of library stack systems.
  2. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Vacuum finished floor and wet mop concrete or access flooring over which shelving is to be installed.

### **3.3 INSTALLATION, GENERAL**

- A. Install library stack systems according to manufacturer's written instructions.
- B. Level bookstack units with integral adjustable leveling devices to a tolerance of 1/8 inch in 96 inches for level and plumb.
- C. Install using anchorage or bracing as recommended by manufacturer and as required for stability. Complete installation to comply with requirements of authorities having jurisdiction.
- D. Install the following with concealed fasteners:
  1. End panels.
  2. Canopy tops.
- E. Install shelves at spacing indicated or, if not indicated, at equal spacing in each unit.
- F. Install custom millwork listed in this Section which is fabricated according to requirements defined in Division 06.

### **3.4 INSTALLATION OF MOBILE STORAGE UNITS**

- A. Fully grout tracks.
- B. Protect tracks during the topping slab pouring process.
- C. Permanently attach shelving units to carriages. Stabilize shelving units to comply with mobile storage unit manufacturer's written requirements. Reinforce shelving units to withstand the stress of movement where required.

- D. Install system to comply with final layout drawings, in strict compliance with manufacturer's printed instructions. Position units level and plumb, at proper location relative to adjoining units and related work.
- E. Field Quality Control: Remove and replace components that are chipped, scratched, or otherwise damaged and which do not match adjoining work. Unless indicated otherwise, provide new matching units, installed as specified and in manner to eliminate evidence of replacement or salvage.
- F. Adjust components and accessories to provide smoothly operating, visually acceptable installation.
- G. Cleaning: Immediately upon completion of installation, clear components and surfaces. Remove surplus materials, rubbish and debris resulting from installation upon completion of work and leave areas of installation in neat, clean condition.

### **3.5 INSTALLATION TOLERANCES**

- A. Install tracks parallel and level within 3/32 inch for each length; 1/16 inch between adjacent tracks perpendicular to track direction; and 1/32 inch in 10 feet of track length.
  - 1. Comply with specified tolerances or with manufacturer's requirements, whichever is more stringent.

### **3.6 DEMONSTRATION**

- A. Startup Services: Engage a factory-authorized service representative to perform startup services and to train Owner's maintenance personnel as specified below:
  - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 2. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing and preventative maintenance.
  - 3. Review data in the maintenance manuals. Refer to Division 1 Section "Closeout Requirements."
  - 4. Schedule training with Owner, through Architect, with at least 7 days advance notice.

### **3.7 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum
  - 2. Plastic Materials and Gaskets
  - 3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  - 1. Treated, stained, painted or contaminated wood.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling

**END OF SECTION 11 51 23**

## **SECTION 11 51 24 – LIBRARY EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. New rolling book cart for installation at main circulation desk.
  - 2. Installation of existing 2-gate magnetic security gates in main lobby.
  - 3. Cleaning and relocation of existing freestanding exterior book drop unit.
- B. Related Sections:
  - 1. Division 06 Section "Interior Architectural Woodwork" for millwork enclosures for library equipment.
  - 2. Division 11 Section "Mobile & Fixed Library Stack Systems" for new and refurbished library shelving.
  - 3. Division 26 Sections for electrical work related to library equipment.
  - 4. Division 27 Sections for communications work related to library equipment.
  - 5. Division 28 Section "Security Systems" for work related to library equipment.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for library equipment. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For library equipment. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring Diagrams: For power, signal, communication, security and control wiring.
- C. Qualification Data: For qualified Installer.
- D. Operation and Maintenance Data: For library equipment to include in emergency, operation, and maintenance manuals.

#### **1.4 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 ROLLING BOOK DROP CART**

- A. Basis of Design: Duralight 40 Series Standard Capacity Cart, Catalog # 30-9040, as manufactured by Kingsley Companies, or approved equivalent.
  - 1. Materials: 16 gauge aluminum, with durable felt pad to help protect collection from damage.



2. Capacity: 9.3 cu ft; 350 lbs weight capacity and load limit.
3. Features: Spring assembly float tray lowers as materials are received and raises as materials are removed.
4. Weight: 33 lbs.
5. Overall Dimensions: 25.5"W x 28.5"D x 31.5" H – height includes casters; depth includes handle.
6. Casters:
  - a. 4" diameter, non-marring.
  - b. Plate mounted, ball bearing.
  - c. Located at four corners; two swivel and two locking.
7. Finish: black textured powder coat.
8. Warranty: Limited Lifetime.

## **2.2 MAGNETIC SECURITY GATES, EXISTING**

- A. Product: Relocate existing 3M library security gates.
  1. Reinstall existing gates in new construction as shown in details. Provide new parts as required.
  2. Existing gates are a dual corridor system with three lattices.
  3. System shall be safe for magnetic media.
  4. Integrated audio and visual alarms shall alert staff when a secured item is detected. Alarm lights shall be located at the top of each gate.
  5. An incrementing counter shall automatically keep a tally of the number of customers passing through the detection system.
  6. Dimension between gates shall be as indicated in the Drawings, but not less than 36 inches.
  7. Detection system electronics shall be enclosed inside each lattice and in a wall mounted electronics enclosure.
  8. Installation: Buried Cable. Coordinate requirements with concrete subcontractor prior to concrete pours.
  9. Contractor shall plan the system and equipment layout so that customers entering and exiting the building do not interfere with each other.

## **2.3 EXISTING EXTERIOR BOOK DROP UNIT**

- A. Rehabilitate existing exterior book drop unit.
  1. Clean thoroughly.
  2. Paint all exposed surfaces. See Division 08 Section "Painting."
  3. Bolt book drop unit to paving in location selected by Architect.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, including equipment bases; accurate placement, pattern, and orientation of anchor bolts; critical dimensions; and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical systems to verify actual locations of connections before parking control equipment installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. General: Install equipment as required for a complete and integrated installation.

1. Rough-in electrical connections according to requirements specified in Division 26 Sections.
- B. Gates: Anchor to concrete bases with anchor bolts or expansion anchors and mount gates.
  1. Connect equipment to remote computer.
  2. Coordinate the installation of multiple gates to the Owner's computer system, ensuring that there is no interference between gates.

### **3.3 PROTECTION**

- A. Protect gates during the construction period to prevent damage.

### **3.4 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated areas for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  1. Aluminum
  2. Plastic Materials and Gaskets
  3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
  1. Treated, stained, painted or contaminated wood.
- D. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 11 51 24**

## **12 24 13 – ROLLER WINDOW SHADES**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Manual roller shades.
- B. Motorized roller shades.
- C. Shade accessories.

#### **1.2 RELATED REQUIREMENTS**

- A. See Division 12 Section "Window Shade Control System": Automated solar adaptive control system for motorized window shades.
- B. See Division 26 for associated electrical requirements.

#### **1.3 REFERENCE STANDARDS**

- A. 47 CFR 15 - Radio Frequency Devices; current edition.
- B. ISO 9001 - Quality management systems -- Requirements; 2015.
- C. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems; Current Edition, Including All Revisions.
- E. WCMA A100.1 - Safety of Window Covering Products; 2018.

#### **1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Motorized Shades:
    - a. Where motorized shades are to be controlled by control systems provided under other sections, coordinate the work with other trades to provide compatible products.
    - b. Coordinate the work with other trades to provide rough-in for electrical wiring as required for installation of motorized shades.
  - 2. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.
- B. Preinstallation Meeting: Conduct on-site meeting with shade control system installer prior to commencing work to review:
  - 1. Low voltage wiring requirements.
  - 2. Separation of power and low voltage/data wiring.
  - 3. Wire labeling.
  - 4. Control locations.
  - 5. Connections to other equipment.
  - 6. Installer responsibilities.
  - 7. Pocket and/or mounting conditions.
- C. Sequencing:
  - 1. Do not fabricate shades until field dimensions for each opening have been taken.

2. Do not install shades until final surface finishes and painting are complete.

## **1.5 SUBMITTALS**

- A. See Division 01 Sections for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets including materials, finishes, fabrication details, dimensions, profiles, mounting requirements, and accessories.
  1. Motorized Shades: Include power requirements and standard wiring diagrams.

## **1.6 QUALITY ASSURANCE**

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications:
  1. Motorized Shades: Company with not less than twenty years of experience manufacturing low voltage motorized shading systems.
  2. Registered to ISO 9001, including in-house engineering for product design activities.
  3. Qualified to supply specified products and to honor claims against product presented in accordance with warranty.
  4. Maintains technical support available 24 hours per day, 7 days per week, excluding manufacturer holidays.
  5. Maintains separate field service division responsible for startup, service, and troubleshooting of shading system and associated lighting control system, where applicable.
- D. Shade Installer Qualifications: Qualified to install and troubleshoot specified products by prior factory training, experience, demonstrated performance, and acceptance of any requirement of the manufacturer, subsidiary of the manufacturer, or licensed agent.
- E. Mockups: Provide installations of roller window shades in the following locations for approval prior to proceeding with job.
  1. Manual Window Shade: Dean's Office 418A.
  2. Motorized Window Shade: Conference 417.

## **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver shades in manufacturer's unopened packaging, labeled to identify each shade for each opening.
- B. Handle and store shades in accordance with manufacturer's recommendations.

## **1.8 FIELD CONDITIONS**

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.
  1. Basis of Design System Requirements – Lutron, or approved equivalent, Unless Otherwise Indicated:
    - a. Ambient Temperature: Between 32 and 104 degrees F (0 and 40 degrees C).
    - b. Relative Humidity: Less than 90 percent, non-condensing.

## **1.9 WARRANTY**

- A. See Division 01 Sections for additional warranty requirements.

- B. Manufacturer's Warranty; Lutron 8-Year Limited Warranty:
  - 1. Shade Control System Components (including shade electronic drive units, shade fabric, and shade hardware):
    - a. Years 1-5: 100 percent replacement parts coverage, no manufacturer labor coverage.
    - b. Years 6-8: 50 percent replacement parts coverage, no manufacturer labor coverage.
    - c. Telephone Technical Support: Available 24 hours per day, 7 days per week, excluding manufacturer holidays.
  - 2. External Shade Control System Components (including control stations, interfaces, and system accessories):
    - a. One year 100 percent replacement parts coverage, 100 percent manufacturer labor coverage to troubleshoot and diagnose a shade control issue.
    - b. Telephone Technical Support: Available 24 hours per day, 7 days per week, excluding manufacturer holidays.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Basis of Design Manufacturer: Lutron Electronics Company, Inc , or approved equivalent.
  - 1. Contract Roller; [www.lutron.com/#sle](http://www.lutron.com/#sle). Project Contact: Richard Rosenbaum, SES, richardr@ses95.com
- B. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

### **2.2 WINDOW SHADE FABRIC APPLICATIONS**

- A. Fabric for Roller Shades:
  - 1. Shade Fabric:
    - a. Fabric Family Name: Lutron E Screen.
    - b. Color: To be selected by Architect from full range of options.
      - 1) Fabric Performance Requirements - General Purpose/Sustainable Solar Screen/Blackout:
        - a) Openness Factor: 3%.
        - b) Visible Light Transmittance (Tv): 5%.
        - c) Solar Transmittance (Ts): 5%.
        - d) Solar Absorption (As): 85%.
        - e) Solar Reflectance (Rs): 10%.
    - c. Other Fabric Properties:
      - 1) Fire Rating: NFPA 701, CA Title 19, CAN/ULC-S109.
      - 2) Material Composition: 36% Fiberglass, 64% Vinyl.
- B. Solar Screen Fabric General Requirements:
  - 1. Fabric Performance Selection:
    - a. Fabrics must be selected based on evaluation using a building model.
    - b. Model must incorporate location, facade orientation(s), window size(s), glass properties, and interior layout and properties.
    - c. Submit report documenting glare, daylight, and view performance results.

### **2.3 ROLLER SHADES**

- A. General Requirements:
  - 1. Provide fully-factory assembled window shades complete with mounting brackets, operating mechanisms, hembars, hardware and accessories.
  - 2. Size: As indicated on drawings.
  - 3. Mounting: Inside or outside mount as indicated on drawings.

4. Roller Tube: Manufacturer's standard, selected for suitability for installation conditions, span, and weight of shades.
  - a. Material: Aluminum.
  - b. Aluminum Recycled Content for Roller Tubes and Top Treatments:
    - 1) 50 percent post-industrial recycled content.
    - 2) 25 percent post-consumer recycled content.
    - 3) 25 percent primary aluminum.
  - c. Designed to prevent rust stains.
5. Fabric Drop: Regular roll.
6. Fabric Attachment: Utilize double-sided adhesive strip with minimum of one turn of fabric on roller before working section of fabric starts.
7. Hembars: Wall thickness designed for weight requirements and adaptation to uneven surfaces, to maintain bottom of shade straight and flat.

B. Manual Shades:

1. Product: Lutron Contract Roller Manual Shades.
2. Operating Mechanism: Clutch operated continuous loop with beaded ball pull chain.
3. Clutch Construction:
  - a. Consists of three brake springs on a cylindrical metallic mandrel lubricated with silicone-based lubricant to ensure smooth and reliable operation.
  - b. Includes field-configurable chain routing clip designed to ensure chain is in constant contact with clip for smooth and quiet operation when raising shades.
4. Provide pull chain tensioning device complying with WCMA A100.1.
5. Clutch/Pull Chain Configuration: Right- or left-mounted as indicated on drawings.

C. Motorized Shades:

1. Product(s):
  - a. Low-voltage wired shades with wired (low voltage) communications; Lutron Contract Roller: QS Motorized Shades, or approved equivalent.
2. Listed as complying with UL 325.
3. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of 47 CFR 15, for Class B application.
4. Audible Noise: Capable of operating at or below 44 dBA measured 3 feet (1 m) from the center of the shade depending on the electronic drive unit selected; no audible clicks when motor starts and stops.
5. Electronic Drive Units:
  - a. Low-voltage, for connection to NFPA 70, Class 2 power source.
  - b. Size and configuration as recommended by manufacturer for the type, size, and arrangement of shades to be operated.
  - c. Concealed from interior view.
6. Coupling of Multiple Shades:
  - a. Where possible, minimize number of electronic drive units by coupling adjacent shades.
  - b. Utilize adjustable coupler that allows for precision adjustment of hembar levels without removing the installed roller or removing the fabric from the roller tube.
7. Adjustment Provisions:
  - a. Sub-brackets support shade during installation and allow for lateral position adjustment for consistent light gaps.
  - b. Level adjustment screws at each idler position allow for level adjustment without requiring shimming of shade brackets.

## 2.4 SHADE ACCESSORIES

- A. Brackets and Mounting Hardware: Size as recommended by manufacturer for mounting configuration and span indicated.
1. Brackets for mounting a shade and optional fascia.
- B. Fasteners: Non-corrosive, and as recommended by shade manufacturer.

- C. Top Treatments:
  - 1. Provide top treatments consistent across manual and motorized shade products.
  - 2. Fascia: Size as required to conceal shade mounting; provide matching endcaps.
    - a. Color/Finish: As selected from manufacturer's standard colors.

## **2.5 MOTORIZED SHADE CONTROLS**

- A. Motorized shades to be controlled by automated window shade control system and associated control devices as specified in Division 12 Section "Window Shade Control System."

## **2.6 SHADE FABRICATION**

- A. Field measure finished openings prior to ordering or fabrication.
- B. Dimensional Tolerances: As recommended in writing by manufacturer.
- C. At openings requiring continuous multiple shade units with separate rollers, locate roller joints at window mullion centers; butt rollers end-to-end.

## **2.7 SOURCE QUALITY CONTROL**

- A. See Division 01 Sections for additional requirements.
- B. Factory Testing; Lutron Standard Factory Testing:
  - 1. Perform full-function factory inspection and testing on all completed assemblies. Statistical sampling is not acceptable.
  - 2. Comprehensive factory inspection and testing on each shade includes, but is not limited to:
    - a. Mount and operate shades; examine for fabric flaws, hembar levelness, telescoping.
    - b. Verify shade/fabric dimensions.
    - c. Verify synchronization/tracking within specified tolerance for motorized shades.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine finished openings for deficiencies that may preclude satisfactory installation.
- B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.
- C. Start of installation shall be considered acceptance of substrates.

### **3.2 PREPARATION**

- A. Prepare surfaces using methods recommended by manufacturer for achieving best result for substrate under the project conditions.
- B. Coordinate with window installation and placement of concealed blocking to support shades.

### **3.3 INSTALLATION**

- A. Install products in accordance with manufacturer's instructions.
- B. Shade Installation:
  - 1. Install in accordance with approved shop drawings, using mounting devices as indicated.

2. Replace shades that exceed specified dimensional tolerances at no extra cost to Owner.
3. Adjust level, projection and shade centering from mounting bracket where applicable.

### **3.4 FIELD QUALITY CONTROL**

- A. See Division 01 Sections for additional requirements.
- B. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

### **3.5 CLEANING**

- A. Clean soiled shades and exposed components as recommended by manufacturer.
- B. Replace shades that cannot be cleaned to "like new" condition.

### **3.6 PROTECTION**

- A. Protect installed products from subsequent construction operations.
- B. Touch-up, repair or replace damaged products before Substantial Completion.

### **3.7 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  1. Aluminum.
  2. Plastic Materials
  3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 12 24 13**



## **12 25 00 – WINDOW SHADE CONTROL SYSTEM**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Automated window shade control system and associated components:
  - 1. Shade control system hubs.
  - 2. Shade control system computers.
  - 3. Shade control system software.
  - 4. Control stations.
  - 5. Low-voltage control interfaces.
  - 6. Accessories.

#### **1.2 RELATED REQUIREMENTS**

- A. See Division 12 Section “Roller Window Shades.”
- B. See Division 26 for associated electrical requirements.

#### **1.3 REFERENCE STANDARDS**

- A. ASTM D4674 - Standard Practice for Accelerated Testing for Color Stability of Plastics Exposed to Indoor Office Environments; 2002a (Reapproved 2010).
- B. IEC 61000-4-2 - Electromagnetic Compatibility (EMC) - Part 4-2: Testing and Measurement Techniques - Electrostatic Discharge Immunity Test; 2008.
- C. ISO 9001 - Quality management systems -- Requirements; 2015.
- D. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- E. NECA 130 - Standard for Installing and Maintaining Wiring Devices; 2010.
- F. NEMA WD 1 - General Color Requirements for Wiring Devices; 1999 (Reaffirmed 2015).
- G. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

#### **1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
  - 1. Coordinate the placement of sensors and wall controls with millwork, furniture, equipment, etc. installed under other sections or by others.
  - 2. Coordinate the placement of wall controls with actual installed door swings.
  - 3. Coordinate the placement of shadow sensors with windows, skylights, and luminaires to achieve optimum operation. Coordinate placement with ductwork, piping, equipment, or other potential obstructions to light level measurement installed under other sections or by others.
  - 4. Coordinate the work to provide window shades compatible with the shade control system.
  - 5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.
- B. Pre-Wire Meeting: Conduct on-site meeting with shade control system manufacturer prior to commencing work as part of manufacturer's standard startup services. Manufacturer to review with installer:
  - 1. Low voltage wiring requirements.

2. Separation of power and low voltage/data wiring.
3. Wire labeling.
4. Shade control hub locations and installation.
5. Control locations.
6. Computer jack locations.
7. Network wiring requirements.
8. Connections to other equipment and other Lutron equipment.
9. Installer responsibilities.
10. 1Power panel locations.

C. Sequencing:

1. Do not install sensors and wall controls until final surface finishes and painting are complete.

## 1.5 SUBMITTALS

- A. See Division 01 Sections for submittal procedures.
- B. Product Data: Include ratings, configurations, standard wiring diagrams, dimensions, colors, service condition requirements, and installed features.
- C. Shop Drawings:
  1. Provide schematic system riser diagram indicating component interconnections. Include requirements for interface with other systems.
  2. Provide detailed sequence of operations describing system functions.

## 1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications:
  1. Company with not less than ten years of experience manufacturing shade control systems of similar complexity to specified system.
  2. Registered to ISO 9001, including in-house engineering for product design activities.
  3. Qualified to supply specified products and to honor claims against product presented in accordance with warranty.
- D. Mockups: Provide installations of roller window shade controls in the following locations for approval prior to proceeding with job.
  1. Motorized Window Shade: Conference 417.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store products in a clean, dry space in original manufacturer's packaging in accordance with manufacturer's written instructions until ready for installation.

## 1.8 FIELD CONDITIONS

- A. Maintain field conditions within manufacturer's required service conditions during and after installation.
  1. Basis of Design System Requirements – Lutron, or approved equivalent, Unless Otherwise Indicated:
    - a. Ambient Temperature:
      - 1) Manufacturer Shade Control System Components, Except Those Listed Below: Between 32 and 104 degrees F (0 and 40 degrees C).

- 2) Shade Control System Computer: Between 50 and 90 degrees F (10 and 35 degrees C).
- b. Relative Humidity: Less than 90 percent, non-condensing.

## **1.9 WARRANTY**

- A. See Division 01 Sections for additional warranty requirements.
- B. Manufacturer's Warranty; Lutron 8-Year Limited Warranty:
  1. Shade Control System Components (including shade electronic drive units, shade fabric, and shade hardware):
    - a. Years 1-5: 100 percent replacement parts coverage, no manufacturer labor coverage.
    - b. Years 6-8: 50 percent replacement parts coverage, no manufacturer labor coverage.
    - c. Telephone Technical Support: Available 24 hours per day, 7 days per week, excluding manufacturer holidays.
  2. External Sivoia Shade Control System Components (including control stations, interfaces, and system accessories):
    - a. With Factory Startup: 2 year 100 percent replacement parts coverage, 100 percent manufacturer labor coverage to troubleshoot and diagnose a shade control issue.
    - b. Telephone Technical Support: Available 24 hours per day, 7 days per week, excluding manufacturer holidays.
  3. Shade Control System Computer: One year 100 percent parts coverage, one year 100 percent manufacturer labor coverage.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Basis of Design Manufacturer: Lutron Electronics Company, Inc , or approved equivalent.
- B. Source Limitations: Furnish products produced by a single manufacturer and obtained from a single supplier.

### **2.2 WINDOW SHADE CONTROL SYSTEM – GENERAL REQUIREMENTS**

- A. Provide products listed, classified, and labeled by Underwriter's Laboratories Inc. (UL) as suitable for the purpose indicated.
- B. Unless specifically indicated to be excluded, provide all required equipment, conduit, boxes, wiring, connectors, hardware, supports, accessories, software, system programming, etc. as necessary for a complete operating system that provides the control intent indicated.
- C. Shade Control Requirements:
  1. Capable of operating shades and recalling shade presets via keypad, contact closure input, infrared receiver, lighting management system software, or other lighting control system interface.
  2. Capable of operating any individual, group, or subgroup of shade electronic drive units within system without requiring separate group controllers.
  3. Capable of assigning and reassigning individual, groups, and subgroups of shades to any control within system without requiring additional wiring or hardware changes.
  4. Capable of controlling shade speed for tracking within plus or minus 0.125 inch (3.17 mm) throughout entire travel.
  5. Provide 10 year power failure memory for preset stops, open and close limits, shade grouping and sub grouping and system configuration.

6. Capable of synchronizing multiple shade electronic drive units of the same size to start, stop and move in unison.
  7. Capable of stopping shades within accuracy of 0.125 inch (3.17 mm) at any point between open and close limits.
  8. Capable of storing up to 250 programmable stop points, including open, close, and any other position.
  9. Capable of controlling lights and shades from single wall control button.
- D. Design shade control equipment for 10 year operational life while operating continually at any temperature in an ambient temperature range of 32 degrees F (0 degrees C) to 104 degrees F (40 degrees C) and 90 percent non-condensing relative humidity.
- E. Electrostatic Discharge Tolerance: Design and test equipment to withstand electrostatic discharges without impairment when tested according to IEC 61000-4-2.
- F. Device Finishes:
1. Standard Colors: Comply with NEMA WD 1 where applicable.
  2. Color Variation in Same Product Family: Maximum delta E of 1, CIE L\*a\*b color units.
  3. Visible Parts: Exhibit ultraviolet color stability when tested with multiple actinic light sources as defined in ASTM D4674. Provide proof of testing upon request.

### **2.3 SHADE CONTROL SYSTEM HUBS**

- A. Product: Lutron Quantum Hub, or approved equivalent.
- B. Provided in a pre-assembled NEMA listed enclosure with terminal blocks listed for field wiring.
- C. Connects to controls via RS485.
- D. Enables shade control system software to control and monitor compatible window treatments.
1. Utilizes Ethernet connectivity to shade control system computer utilizing one of the following methods:
    - a. Dedicated network.
    - b. Dedicated VLAN.
    - c. Shared network with Building Management System (BMS).
    - d. Corporate network where managed switches are configured to allow multicasting and use of IGMP.
- E. Integrates control station devices, shades, and external inputs into a single customizable shade control system with:
1. Failsafe Mechanisms:
    - a. Distributed architecture provides fault containment. Single hub failure or loss of power does not compromise shades connected to other shade control system hubs.
  2. Manual overrides.
  3. Automatic control.
  4. Central computer control and monitoring.
- F. Furnished with astronomical time clock.
- G. Maintains a backup of the programming in a non-volatile memory capable of lasting more than ten years without power.
- H. Integration with other devices over Ethernet via Telnet using the Lutron Integration Protocol.
- I. Control other devices over Ethernet via TCP or Telnet by sending device specific strings.

## 2.4 SHADE CONTROL SYSTEM COMPUTERS

- A. Computers:
1. Product: Lutron Q-Manager, or approved equivalent.
  2. Server:
    - a. Suitable for 24 hour per day, 7 day per week programming, monitoring, control, and data logging of shade control system.
    - b. Suitable to handle client machine request in multi-computer systems.
    - c. Unless otherwise indicated, computer to be provided by others, meeting shade control system manufacturer's minimum requirements.
    - d. Minimum Hardware Requirements:
      - 1) Processor: Quad Core Intel Xeonae processor with minimum speed of 2.8 GHz.
      - 2) 8 GB Ram.
      - 3) 250 GB hard drive (40 GB for application and database).
      - 4) Two 10/100/1000 Ethernet network interfaces - one for communication with lighting management hubs and one for communication with corporate intranet to allow access from system PCs and/or energy saving display terminals. Only one Ethernet network interface is required if all lighting management hubs and client PCs are on the same network.
      - 5) Monitor with 1280 x 1024 resolution.
      - 6) 4 USB 2.0 ports.
      - 7) Dedicated Graphics Card with 256 MB of memory.
    - e. Minimum Software Requirements:
      - 1) Licensed installation of US English 64-bit Microsoft Windows Server 2008 R2 or Windows Server 2012 R1.
      - 2) Microsoft Internet Information Services (IIS) 7 or later.
      - 3) Microsoft Internet Explorer 9 or later.
      - 4) Microsoft .NET Framework 3.5.

## 2.5 SHADE CONTROL SYSTEM SOFTWARE

- A. Provide system software license and hardware that is designed, tested, manufactured, and warranted by a single manufacturer.
- B. Configuration Setup Software:
1. Product: Lutron Q-Design, or approved equivalent.
  2. Suitable to make system programming and configuration changes using a graphical floor plan view or a generic system layout.
  3. Windows-based, capable of running on either central server or a remote client over TCP/IP connection.
  4. Publish Graphical Floor Plan: Allows the user to publish new graphical floor plan files, allowing users to monitor the status of shades.
  5. Back-Up Project Database: Allows the user to back up the project database that holds all the configuration information for the system, including keypad programming and time clock.
  6. Publish Project Database: Allows the user to send a new project database to the server and download the new configuration to the system. The project database holds all the configuration information for the system, including keypad programming and time clock.
  7. Allows manufacturer (with service call) or user (with training) to:
    - a. Capture system design:
      - 1) Geographical layout.
      - 2) Shade grouping.
      - 3) Equipment schedule.
      - 4) Equipment assignment to shade control system hubs.
    - b. Define the configuration for the following in each area:
      - 1) Shade group presets.
      - 2) Control station devices.

- 3) Interface and integration equipment.
  - c. Startup:
    - 1) Addressing.
    - 2) Provide customized conditional programming.
- C. Control and Monitor Software:
1. Product: Lutron Quantum Vue, or approved equivalent.
  2. General Requirements:
    - a. Web-based; runs on most HTML5 compatible browsers (including Internet Explorer, Chrome, and Safari).
    - b. Supports multiple platforms and devices; runs from a tablet, desktop, laptop, or smartphone; optimized for displays of 1024 by 768 pixels or higher.
    - c. User interface supports multi-touch gestures such as pinch to zoom, drag to pan, etc.
    - d. Utilizes HTTPS (industry-standard certificate-based encryption and authentication for security).
    - e. All functionality listed below must be available via a single application.
  3. System Navigation and Status Reporting:
    - a. Performed using graphical floor plan view or a generic system layout.
    - b. Graphical Floor Plan View: Utilizes customized CAD based drawing of the building. Pan and zoom feature allows for easy navigation; dynamically adjusts the details presented based on zoom level.
    - c. Area, scene, and zone names can be changed in real time.
  4. Control of Shades:
    - a. Area shades can be monitored for current preset or position.
    - b. Area shades can be opened/closed, sent to a preset, or sent to a specific position.
  5. Scheduling: Schedule time of day and astronomic time clock events to automate functions.
  6. Reporting: Provide reporting capability that allows the building manager to gather real-time and historical information about the system as follows:
    - a. Activity Report: Show what activity has taken place over a period of time for one or more areas. Activity includes occupant activities (e.g. wall controls being pressed), building manager operation (e.g. controlling/changing areas using the control and monitor tool), device failures (e.g. keypads that are not responding), and shade related activities (e.g. manual overrides from personal controls, automatic overrides from sensors).
    - b. Shade Level Report: Shows the shade level for any shade group in the system over any historical 24 hour period.
    - c. Shade Position Report: Shows the percentage of time shade groups in the system are at each position.
    - d. Sensor Level Report: Shows the light level in footcandles over time of any photosensor in the system.
    - e. Automated Shade Control Activity Report: A single chart that displays historical data regarding the position and performance of automated shades for a given shade group, which can be displayed over any single hour or 24 hour period, and includes the following:
      - 1) Shade Level: Shows the shade level for any shade group in the system over the time period, and also indicates the reason for shade movement.
      - 2) Sensor Level: Shows the light level in footcandles over time for a given shade group.
      - 3) Sensor Threshold: Shows the sensor override thresholds in footcandles over time for a given shade group.
      - 4) Shows the system mode transitions over time (Dark Override, Bright Override, Manual Override, etc.).
      - 5) Sun Position: Shows the sun position with respect to the facade.
      - 6) Shade Positional Parameter: Expected position of the shade under normal, bright, or dark operations.

7. Diagnostics: Allows the building manager to check on the status of all equipment in the shade control system. Devices to be listed with a reporting status of OK, missing, or unknown.
8. Alerts and Alarms: Monitors the system for designated events/triggers and automatically generates alerts according to configured response criteria.
  - a. Capable of monitoring for the following events/triggers:
    - 1) A failed piece of equipment (e.g. control, sensor, etc.); alert cleared when equipment is replaced.
    - 2) Low battery conditions in battery-operated sensors and controls; alert cleared when battery is replaced.
    - 3) Potential sensor failures (Radio Window sensors that have not seen a change in light level).
  - b. View alerts on a customized graphical floor plan.
  - c. Capable of generating alerts through visible changes in software or through email messages.
  - d. Capable of customizing the frequency of alerts and providing notifications immediately or through daily, weekly, or monthly summaries.
9. Administration:
  - a. Users: Allows new user accounts to be created and existing user accounts to be edited.
    - 1) Supports Active Directory (LDAP) tying user accounts to network accounts.
  - b. Area and feature access can be restricted based on login credentials with three levels of access rights (Admin, Programmer, Controller) and customized access levels available.
10. Favorite Buttons: Provide global scene control or modes of operation across the entire system.
11. Variables: Used for custom program of a system and/or to signal a third party system. Any change may cause a change in the behavior of the system.
  - a. View the current state of system variables across subsystems.
  - b. Update the current variable state across all subsystems.
12. Device Lock/Unlock: Allows the building manager to lock control station devices to prevent building occupants from activating their programming (button presses), until they are unlocked.
  - a. Keypads can be locked to help ensure occupants cannot change light and shade levels in a public space during specific events or business hours.
  - b. Keypads can be unlocked after events/during after hours to allow maintenance, cleaning, security, and others to perform their tasks without needing to contact a building manager.

D. Automated Shade Control Software:

1. Product: Lutron, or approved equivalent.
2. Objectives:
  - a. Optimizes energy savings from daylight.
  - b. Provides manual override capability for occupants via wall-mounted keypad or simple remote control.
  - c. Provides automatic override capability utilizing a local sensor in dark conditions or when excessive brightness occurs.
  - d. Maximizes occupant's connectivity with outdoors by optimizing view.
  - e. Provides diffuse daylight and minimizes direct sunlight in the space to reduce solar heat gain and maximize occupant comfort in the space.
  - f. Reduces glare.
  - g. Shades along same facade to start, stop and track in unison to maintain a consistent exterior aesthetic.
  - h. Provides optional presets to allow shades to align with architectural elements of the facade.
  - i. Provides a preset, also referred to as visor position, to limit maximum amount of light entering a space.
  - j. Provides configurable dark and bright override positions.

3. Control Software:
  - a. Controlled using the following inputs for startup:
    - 1) Building location.
    - 2) Facade orientation.
    - 3) Window dimensions.
    - 4) Solar depth of penetration.
    - 5) Number of shade movements per day.
    - 6) Visor position of shades.
    - 7) Optional presets that align shades with architectural features of the facade.
    - 8) Light level thresholds for dark and bright override.
    - 9) Shade position for dark and bright override.
  - b. Requires minimal long term maintenance and service. Does not require user to make daily changes to programming or overall system functionality, unless desired by owner.
4. Automated Shade Operation Adjustment and Configuration:
  - a. Access to all adjustable parameters (e.g. solar depth of penetration, number of shade movements per day, manual override timeout, run schedules, override levels).
  - b. Manual adjustment of any parameter.
  - c. Calculates and recommends adjustments.
    - 1) Software algorithm computes recommendations.
    - 2) Recommendation based on space end-user experience.
      - a) Space too bright.
      - b) Space too dark.
      - c) Shades move too frequently.
      - d) For specified shade.
      - e) For specified time.
    - 3) Recommendation tweaks any or all adjustable parameters to improve shade performance.
5. Override:
  - a. Manual:
    - 1) Temporary override of the control program capability through optional manual keypads, remote controls, or end-user control software.
    - 2) Keypads, remote controls, or end-user control software to be capable of providing manual control of shades in a particular area.
    - 3) Time of manual override to be programmable.
  - b. Automatic overrides achievable via Radio Window sensors or rooftop cloudy day sensors.
    - 1) Radio Window Sensors:
      - a) Product(s): Lutron Radio Window sensor; Model LRF2-SSM-XX (mullion mount sensor pair) or approved equivalent.
      - b) Monitors exterior light conditions and provides automatic override of system on dark cloudy days or in the presence of shadows from neighboring buildings and rooftop mechanical equipment.
      - c) Capable of detecting a light range of 0 to 10,000 footcandles (0 to 107,000 lux).
      - d) Sensors update the system with the light level conditions based on daylight event changes, not periodic transmissions.
      - e) During dark conditions, shades to go to predetermined dark override position to maximize view and available daylight.
      - f) (Monitors exterior light conditions and provides automatic override of system during excessive brightness.
      - g) During excessive bright conditions, shades to go to predetermined bright override position to maximize occupant comfort.
      - h) Capable of having one or multiple sensors per facade for more localized detection of exterior light conditions.
      - i) Capable of having one sensor control one shade group or multiple shade groups.



- j) Provides flexible grouping capabilities to achieve optimal hembar alignment and daylight autonomy by allowing for any of the following three grouping options in the software:
  - Smart Adaptive Grouping: Shades in the same facade share sensor data and intelligently adapt grouping to balance daylight autonomy, hembar alignment, and maintain consistent shade positions for groups with similar perceived daylight conditions.
  - Always Aligned: Shades in the same facade share sensor data and always maintain hembar alignment across the entire facade.
  - Independent Grouping: Shades in the same facade operate independently based on individual sensor data.
- k) Software enables the ability to adjust thresholds, timeouts, and shade movement frequency globally or per area to meet the unique preferences of different individuals.
- l) Sensor to not require external power packs, power wiring, or communication wiring.
- m) Light level readings of the two mullion mount sensors to be combined together to act as one sensor.
- n) Sensor to be easily mountable to mullion (mullion mount sensor pair) or window (window mount) and can be easily removed and repositioned without marring or damaging window surface.
- o) Provides typical battery lifetime of 7 to 10 years when installed per manufacturer instructions.
- p) Communicates directly to compatible Lutron QS sensor module via Lutron Clear Connect Technology to ensure reliable RF communications.
- q) RF Frequency: 434 MHz.
- r) RF Range: 30 feet (9 m) between sensor and compatible RF receiving device(s).
- s) Intuitive test mode to provide instant system verification of associated shades and programmed visor position.

## 2.6 CONTROL STATIONS

- A. Provide control stations with configuration as indicated or as required to control the loads as indicated.
- B. Wired Control Stations:
  - 1. General Requirements:
    - a. Power: Class 2 (low voltage).
    - b. UL listed.
    - c. Provide faceplates with concealed mounting hardware.
    - d. Borders, logos, and graduations to use laser engraving or silk-screened graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning.
    - e. Finish: As specified for wall controls in "Device Finishes" under WINDOW SHADE CONTROL SYSTEM - GENERAL REQUIREMENTS article above.
  - 2. Wired Keyswitch:
    - a. Product: Lutron QS Keyswitch, or approved equivalent.
    - b. Configuration:
      - 1) Two position, maintained, center position key removal; Lutron Model QSW2-KSI-2MAC.
    - c. Allows control of any devices part of the shade control system.
    - d. Communications: Utilize RS485 wiring for low-voltage communications link.
    - e. Functionality:
      - 1) Allows for easy reprogramming without replacing unit.
      - 2) Requires key insertion to activate actions.

- f. Engrave keypads with button, zone, and scene descriptions as indicated on drawings.
  - g. Software Configuration:
    - 1) Customizable control station device button functionality:
      - a) Key positions can be programmed to perform single defined action.
      - b) Key positions can be programmed using conditional logic off of a state variable such as time of day or partition status.
- C. Wireless (Radio Frequency) Controls:
- 1. Product(s):
    - a. 3-Button with Raise/Lower Control; Lutron Pico Wireless Control Model PJ2-3BRL.
  - 2. Communicates via radio frequency to compatible window treatments.
  - 3. Does not require external power packs, power or communication wiring.
  - 4. Allows for easy reprogramming without replacing unit.
  - 5. Button Programming:
    - a. Single action.
    - b. Toggle action.
    - c. Defined action on press and defined action on release.
  - 6. Includes LED to indicate button press or programming mode status.
  - 7. Mounting:
    - a. Capable of being mounted with a table stand or directly to a wall under a faceplate.
    - b. Faceplates: Provide concealed mounting hardware.
  - 8. Power: Battery-operated with minimum ten-year battery life.
  - 9. Finish: As specified for wall controls in "Device Finishes" under WINDOW SHADE CONTROL SYSTEM - GENERAL REQUIREMENTS article above.

## 2.7 LOW-VOLTAGE CONTROL INTERFACES

- A. Provide low-voltage control interfaces as indicated or as required to control the loads as indicated.
- B. Connects to shade control system hub via RS485.
- C. UL listed.
- D. Sensor Modules:
  - 1. Products:
    - a. Sensor module with both wired and wireless inputs; Lutron Model QSM2-4W-C, or approved equivalent.
  - 2. Wireless Modules:
    - a. Provide wireless communication inputs for:
      - 1) Shadow sensors.
      - 2) Wireless controller.
    - b. RF Range: 30 feet (9 m) between sensor and compatible RF receiving devices.
    - c. RF Frequency: 434 MHz; operates in FCC governed frequency spectrum for periodic operation; continuous transmission spectrum is not permitted.
  - 3. Communicate sensor information to wired low-voltage digital link for use by compatible devices.

## 2.8 ACCESSORIES

- A. Provide power supplies as indicated or as required to power system devices and accessories.
  - 1. Product(s):
    - a. Ten output power supply panel for shades, keypads, and accessories, and for providing additional low voltage power to communication link; Lutron Model QSPS-10PNL; no replaceable fuses required for overload/miswire protection; contains DOE Level VI Compliant power supplies.

## **2.9 SOURCE QUALITY CONTROL**

- A. See Division 01 Sections for additional requirements.
- B. Factory Testing; Lutron Standard Factory Testing:
  - 1. Perform full-function factory testing on all completed assemblies. Statistical sampling is not acceptable.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that field measurements are as indicated on drawings.
- B. Verify that ratings and configurations of system components are consistent with the indicated requirements.
- C. Verify that mounting surfaces are ready to receive system components.
- D. Verify that conditions are satisfactory for installation prior to starting work.

### **3.2 INSTALLATION**

- A. Perform work in a neat and workmanlike manner in accordance with NECA 1 and, where applicable, NECA 130, except for mounting heights specified in those standards.
- B. Install products in accordance with manufacturer's instructions.
- C. Provide dedicated network between shade control system computer and shade control system hubs.
- D. Assign each shade to a shade group and set control functions.
- E. Ensure that window shadow sensor placement provides an unobstructed view of outdoors. Do not place at a skylight or above indirect luminaires.
- F. Identify system components in accordance with Division 26 Electrical sections.

### **3.3 FIELD QUALITY CONTROL**

- A. See Division 01 Sections for additional requirements.
- B. Manufacturer's Startup Services:
  - 1. Manufacturer's authorized Service Representative to conduct minimum of two site visits to ensure proper system installation and operation.
  - 2. Conduct Pre-Installation visit to review requirements with installer as specified in Part 1 under "Administrative Requirements".
  - 3. Conduct second site visit upon completion of shade control system to perform system startup and verify proper operation:
    - a. Verify connection and location of controls.
    - b. Energize shade control system hubs and download system data program.
    - c. Address devices.
    - d. Verify system operation control by control.
    - e. Verify proper operation of manufacturer's interfacing equipment.
    - f. Verify proper operation of manufacturer's supplied PC and installed programs.
    - g. Provide initial rough calibration of sensors; fine-tuning of sensors is responsibility of Contractor unless provided by Shade Control System Manufacturer as part of

Sensor Layout and Tuning service where specified in Part 2 under "WINDOW SHADE CONTROL SYSTEM - GENERAL REQUIREMENTS".

- h. Train Owner's representative on system capabilities, operation, and maintenance, as specified in Part 3 under "Closeout Activities".
  - i. Obtain sign-off on system functions.
- C. Correct defective work, adjust for proper operation, and retest until entire system complies with contract documents.

### **3.4 CLOSEOUT ACTIVITIES**

- A. Training:
- 1. Include services of manufacturer's authorized Service Representative to perform on-site training of Owner's personnel on operation, adjustment, and maintenance of shade control system as part of standard system start-up services.
    - a. Include training on software to be provided:
      - 1) Configuration software used to make system programming and configuration changes.
      - 2) Control and monitor.

### **3.5 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
- 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers who take back waste for reuse or recycling.

**END OF SECTION 12 25 00**

## **SECTION 12 48 13 – ENTRANCE FLOOR MATS & FRAMES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Roll-up rail mats.
  - 2. Surface-mounted frames.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for floor mats and frames including manufacturer's specifications and installation instructions.
- B. Shop Drawings:
  - 1. Items penetrating floor mats and frames, including door control devices, structural columns and other items shown on the Drawings.
  - 2. Perimeter floor frames.
  - 3. Typical entrance mat and frame details for each type of mat and frame specified.
  - 4. Transitions between mats and adjacent finishes.
  - 5. Indicate direction of traffic on all plan views.
  - 6. Shop drawings in sufficient detail showing layout of mat and frame specified including details indicating construction relative to materials, direction of traffic, spline locations, profiles, anchors and accessories.
- C. Samples for Initial Selection: For each type of product indicated.
- D. Samples for Verification: For each type of product indicated.
  - 1. Submit an assembled section of floor mat and frame members with selected tread insert showing each type of color for exposed floor mat, frame and accessories required,

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For floor mats and frames to include in maintenance manuals. In the form of manufacturer's printed instructions for cleaning and maintaining floor mats.

#### **1.5 QUALITY ASSURANCE**

- A. Source Limitations: Obtain floor mats and frames through one source from a single manufacturer.
- B. Accessibility Requirements: Provide installed floor mats that comply with Section 4.5 in the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
- C. Performance Data:
  - 1. Certified by the NFSI as safe walking surface meets .6 wet SCOF.
  - 2. Provide a 500 lb per wheel rolling load for recessed units and 350 lb per wheel rolling load for surface mounted units.

3. Class I Fire Rated.
4. Removes 98% of foot traffic contaminants within 18' of walking surface.
5. Utilize superior structural aluminum allow 6063-T6 for rail connectors.

## 1.6 PROJECT CONDITIONS

- A. Field Measurements: Indicate measurements on Shop Drawings.
  1. Check actual openings for mats by accurate field measurements before fabrication. Record actual measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of work.

## PART 2 - PRODUCTS

### 2.1 ROLL-UP RAIL MATS

- A. Basis of Design Product: Subject to compliance with requirements, provide "Pedimat with Aluminum Tapered Angle Frame" by Construction Specialties (C/S Group) or approved equivalent.
- B. Roll-up, Aluminum-Rail Hinged Mats:
  1. Model and Description - M1 Pedimat Exposed hinge rail connectors shall be extruded 6063-T6 aluminum complete with perforations for drainage. Tread rails shall be manufactured from high-impact Regrind PET-G complete with co-extruded soft-durometer cushions. Overall depth without frame is 7/16" (11.1 mm).
  2. Tread Inserts - HD – MonoTuft HD™ Carpet shall meet CRI standard for good indoor air quality. Fibers shall include a minimum of 100, 12 mil monofilament fibers per square inch. Each carpet fiber and monofilament shall be fusion-bonded to a rigid two-ply backing to prevent fraying and supplied in continuous splice-free lengths. Anti-static carpet fibers shall contain antimicrobial additive and be treated with Scotchgard® to reduce soiling. Carpet weight shall be 33-oz./yd<sup>2</sup>.
  3. Colors: One color as selected by Architect from manufacturer's full range of standard and premium colors.
  4. Rail Color: Heavy-duty powder coat; one color as selected by Architect from manufacturer's full range of standard and premium colors.
  5. Mat Sizes: As indicated on Drawings.

### 2.2 FRAMES

- A. Surface-Mounted Frames:
  1. TNG - Tapered Angle Frame - shall be a 1/2"(12.7mm) deep recessed frame in 6063-T5 aluminum alloy.
  2. Color: Heavy-duty powder coat; one color as selected by Architect from manufacturer's full range of standard and premium colors.

### 2.3 FABRICATION

- A. Floor Mats: Shop fabricate units to greatest extent possible in sizes indicated. Unless otherwise indicated, provide single unit for each mat installation; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints.
- B. Surface-Mounted Frames: As indicated for permanent surface-mounted installation, complete with corner connectors, splice plates or connecting pins, and post installed expansion anchors.
- C. Coat concealed surfaces of aluminum frames that contact cementitious material with manufacturer's standard protective coating.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and floor conditions for compliance with requirements for location, sizes, and other conditions affecting installation of floor mats and frames.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 2. Field verify and template all locations prior to fabrication to assure proper fit and installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install surface-type units to comply with manufacturer's written instructions; coordinate with entrance locations and traffic patterns.
  - 1. Anchor fixed surface-type frame members to floor with devices spaced as recommended by manufacturer.
- B. Level mats as required such that top of mat aligns with top of adjacent flooring.
- C. Coordinate installation with door thresholds to provide tight joint between thresholds and mats. Adjust doors as required such that door do not rub entrance mats when swinging.

### **3.3 PROTECTION**

- A. After completing frame installation and concrete work, provide temporary filler of plywood or fiberboard in recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.

### **3.4 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
  - 1. Aluminum.
  - 2. Plastic Materials
  - 3. Corrugated cardboard packaging.
- C. Preference is to be given to suppliers/installers who take back waste for reuse or recycling.

**END OF SECTION 12 48 13**

## **SECTION 14 21 23.16 – MACHINE ROOM-LESS ELECTRIC TRACTION ELEVATORS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes machine-room-less electric traction passenger elevators.
- B. Related Requirements:
  - 1. Division 01 Sections for temporary use of elevators for construction purposes.
  - 2. Division 03 Section "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
  - 3. Division 04 Section "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry and for grouting elevator entrance frames installed in masonry walls.
  - 4. Division 05 Section "Structural Steel Framing" for the following:
    - a. Attachment plates, angle brackets, and other preparation of structural steel for fastening guide-rail brackets.
    - b. Hoist beams.
    - c. Structural-steel shapes for subsills.
  - 5. Division 05 Section "Metal Fabrications" for the following:
    - a. Attachment plates and angle brackets for supporting guide-rail brackets.
    - b. Hoist beams.
    - c. Structural-steel shapes for subsills.
    - d. Pit ladders.
    - e. Cants made from steel sheet in hoistways.
  - 6. Division 09 Section "Resinous Matrix Terrazzo Flooring" for finish flooring in elevator cars.
  - 7. Division 22 Sections for sump pumps, sumps, and sump covers in elevator pits.

#### **1.3 DEFINITIONS**

- A. Definitions in ASME A17.1/CSA B44 apply to work of this Section.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include capacities, sizes, performances, operations, safety features, finishes, and similar information.
  - 2. Include Product Data for car enclosures, hoistway entrances, and operation, control, and signal systems.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and large-scale details indicating service at each landing, coordination with building structure, relationships with other construction, and locations of equipment.
  - 2. Include large-scale layout of car-control station and standby power operation control panel.
  - 3. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
- C. Samples for Initial Selection: For each type of exposed finish involving color selection.



- D. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes; 3-inch-square Samples of sheet materials; and 4-inch lengths of running trim members.

## **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity 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.
- C. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway and pit layout and dimensions, as indicated on Drawings, and electrical service including standby power generator, as shown and specified, are adequate for elevator system being provided.
- D. Sample Warranty: For special warranty.

## **1.6 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For elevators to include in emergency, operation, and maintenance manuals.
  - 1. Submit manufacturer's or Installer's standard operation and maintenance manual, according to ASME A17.1/CSA B44 including diagnostic and repair information available to manufacturer's and Installer's maintenance personnel.
- B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
- C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard five-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

## **1.7 QUALITY ASSURANCE**

- A. Installer Qualifications: Elevator manufacturer or an authorized representative who is trained and approved by manufacturer.

## **1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle materials, components, and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

## **1.9 COORDINATION**

- A. Coordinate installation of inserts, sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, inserts, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.

- B. Coordinate locations and dimensions of work specified in other Sections that relates to electric traction elevators including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways and pits.

## 1.10 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
  - 2. Warranty Period: year(s) from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. **Basis of Design:** Subject to compliance with requirements, provide products by the following:
  - 1. [Schindler Elevator Corp.](#); Model 3300 MRL Traction Elevator.
  - 2. Or an approved equivalent.
- B. Source Limitations: Obtain all elevator parts from single manufacturer.
  - 1. Major elevator components, including driving machines, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with ASME A17.1/CSA B44.
- B. Accessibility Requirements: Comply with requirements for accessible elevators in the United States Access Board's ADA-ABA Accessibility Guidelines and with ICC A117.1.
- C. Seismic Performance: Elevator system shall withstand the effects of earthquake motions determined according to [ASCE/SEI 7] <Insert requirement> and shall comply with elevator seismic requirements in ASME A17.1/CSA B44.
  - 1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified."
  - 2. Project Seismic Design Category: B (Site Class is D).
  - 3. Elevator Component Importance Factor: 1.25.
  - 4. Design earthquake spectral response acceleration short period (Sds) for Project is 0.115
  - 5. Provide earthquake equipment required by ASME A17.1/CSA B44.
  - 6. Provide seismic switch required by ASCE/SEI 7.

### 2.3 ELEVATORS

- A. Elevator System, General: Manufacturer's standard elevator systems. Unless otherwise indicated, manufacturer's standard components shall be used, as included in standard elevator systems and as required for complete system.
- B. Elevator Description: Usually delete "Rated Load" Subparagraph below if net platform size is indicated on Drawings or if inside-car dimensions are included in "Car Enclosures" Subparagraph.
  - 1. Rated Load: 3500 lb.
  - 2. Freight Loading Class for Service Elevator(s): Class A.
  - 3. Rated Speed: 150 fpm.

4. Operation System: Selective-collective automatic operation.
5. Auxiliary Operations:
  - a. Standby power operation.
  - b. Earthquake Emergency Operation: Comply with requirements in ASME A17.1/CSA B44.
  - c. Automatic dispatching of loaded car.
  - d. Nuisance-call cancel.
  - e. Loaded-car bypass.
  - f. Automatic operation of lights and ventilation fans.
6. Security Features: Keyswitch operation.
7. Car Enclosures:
  - a. See Drawings for dimensions of car enclosure.
  - b. Front Walls (Return Panels): Satin stainless steel, No. 4 finish.
  - c. Car Fixtures: Satin stainless steel, No. 4 finish.
  - d. Side and Rear Wall Panels: Satin stainless steel, No. 4 finish.
  - e. Reveals: Satin stainless steel, No. 4 finish.
  - f. Door Faces (Interior): Satin stainless steel, No. 4 finish.
  - g. Door Sills: Aluminum.
  - h. Ceiling: Satin stainless steel, No. 4 finish.
  - i. Handrails: 1/2 by 2 inches rectangular satin stainless steel, No. 4 finish, at sides and rear of car.
  - j. Floor recessed and prepared to receive Resinous Matrix Terrazzo Flooring to match elevator lobby.
  - k. Floor Thickness, Including Setting Materials: 3/8" above plywood subfloor.
8. Hoistway Entrances:
  - a. See Drawings for dimensions of hoistway.
  - b. Type: Two-speed side sliding.
  - c. Frames: Satin stainless steel, No. 4 finish.
  - d. Doors: Satin stainless steel, No. 4 finish.
  - e. Sills: Aluminum.
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 satin stainless steel, No. 4 finish.
  - b. Provide hooks for protective pads and one complete set of full-height protective pads.

## **2.4 TRACTION SYSTEMS**

- A. Elevator Machines: Permanent magnet, variable-voltage, variable-frequency, ac-type hoisting machines and solid-state power converters.
  1. Provide regenerative system.
  2. Provide regenerative system that complies with the IgCC.
  3. Limit total harmonic distortion of regenerated power to 5 percent per IEEE 519.
  4. Provide means for absorbing regenerated power when elevator system is operating on standby power.
  5. Provide line filters or chokes to prevent electrical peaks or spikes from feeding back into building power system.
- B. Fluid for Hydraulic Buffers: Fire-resistant fluid.
- C. Inserts: Furnish required concrete and masonry inserts and similar anchorage devices for installing guide rails, machinery, and other components of elevator work. Device installation is specified in another Section.
- D. Machine Beams: Provide steel framing to support elevator hoisting machine and deflector sheaves from the building structure. Comply with Section 05 50 00 "Metal Fabrications" for materials and fabrication.

- E. Car Frame and Platform: Bolted- or welded-steel units.
- F. Guides: Provide manufacturer's standard guides at top and bottom of car and counterweight frames.

## **2.5 OPERATION SYSTEMS**

- A. General: Provide manufacturer's standard microprocessor operation systems as required to provide type of operation indicated.
- B. Auxiliary Operations:
  1. Single-Car 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 located at elevator control room. Manual operation causes automatic operation to cease.
  2. Automatic Dispatching of Loaded Car: When car load exceeds 80 percent of rated capacity, doors begin closing.
  3. Nuisance-Call Cancel: When car calls exceed a preset number while car load is less than a predetermined weight, all car calls are canceled. Preset number of calls and predetermined weight can be adjusted.
  4. Automatic Operation of Lights and Fan: When elevator is stopped and unoccupied with doors closed, lighting, ventilation fan, and cab displays are de-energized after five minutes and are re-energized before car doors open.
- C. Security features shall not affect emergency firefighters' service.
  1. Keyswitch Operation and Car-to-Lobby feature to be coordinated with College.

## **2.6 DOOR REOPENING DEVICES**

- A. Infrared Array: Provide door reopening device with uniform array of 36 or more microprocessor-controlled, infrared light beams projecting across car entrance. Interruption of one or more light beams shall cause doors to stop and reopen.
- B. Nudging Feature: After car doors are prevented from closing for predetermined adjustable time, through activating door reopening device, a loud buzzer shall sound and doors shall begin to close at reduced kinetic energy.

## **2.7 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/CSA B44 on car tops where required by ASME A17.1/CSA B44.
- B. Materials and Finishes: Manufacturer's standards, but not less than the following:
  1. Subfloor: Exterior, C-C Plugged grade plywood, not less than 7/8-inch nominal thickness.
  2. Floor Finish: Specified in Division 09 Section "Resinous Matrix Terrazzo Flooring."
  3. Stainless-Steel Wall Panels: Flush, formed-metal construction; fabricated from stainless-steel sheet.
  4. Fabricate car with recesses and cutouts for signal equipment.
  5. Fabricate car door frame integrally with front wall of car.
  6. Stainless-Steel Doors: Flush, hollow-metal construction; fabricated from stainless-steel sheet.
  7. Sight Guards: Provide sight guards on car doors.
  8. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
  9. Metal Ceiling: Flush panels, with LED downlights in each panel. Align ceiling panel joints with joints between wall panels.

10. Ventilation Fan Efficiency: Not less than 3.0 cfm/W.

## **2.8 HOISTWAY ENTRANCES**

- A. Hoistway Entrance Assemblies: Manufacturer's standard horizontal-sliding, door-and-frame hoistway entrances complete with track systems, hardware, sills, and accessories. Frame size and profile shall accommodate hoistway wall construction.
  - 1. Where gypsum board wall construction is indicated, frames shall be self-supporting with reinforced head sections.
- B. Fire-Rated Hoistway Entrance Assemblies: Door and frame assemblies shall comply with NFPA 80 and be listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction based on testing at as close-to-neutral pressure as possible according to NFPA 252 or UL 10B.
  - 1. Fire-Protection Rating: 90 minute, with 30-minute temperature rise of 450 deg F as required to maintain 2 hour fire rating of elevator hoistway.
- C. Materials and Fabrication: 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; fabricated from stainless-steel sheet.
  - 3. Sight Guards: Provide sight guards on doors matching door edges.
  - 4. Sills: Extruded or machined metal, with grooved surface, 1/4 inch thick.
  - 5. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M.

## **2.9 SIGNAL EQUIPMENT**

- A. General: Provide hall-call and car-call buttons that light when activated and remain lit until call has been fulfilled. Provide vandal-resistant buttons and lighted elements illuminated with LEDs.
- B. Car-Control Stations: Provide manufacturer's standard recessed car-control stations. Mount in return panel adjacent to car door unless otherwise indicated.
  - 1. Mark buttons and switches for required use or function. Use both tactile symbols and Braille.
  - 2. Provide "No Smoking" sign matching car-control station, either integral with car-control station or mounted adjacent to it, with text and graphics as required by authorities having jurisdiction.
- C. Emergency Communication System: Two-way voice communication system, with visible signal, which dials preprogrammed number of monitoring station and does not require handset use. System is contained in flush-mounted cabinet, with identification, instructions for use, and battery backup power supply.
- D. 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. Include travel direction arrows if not provided in car-control station.
- E. Hall Push-Button Stations: Provide one hall push-button station at each landing.
  - 1. Provide manufacturer's standard wall-mounted units.
  - 2. Equip units with buttons for calling elevator and for indicating desired direction of travel.
- F. Hall Lanterns: Units with illuminated arrows; but provide single arrow at terminal landings. Provide the following:
  - 1. Units mounted in jamb of entrance frame.

- G. 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.
  - 1. At manufacturer's option, audible signals may be placed on cars.
- H. Emergency Pictorial Signs: Fabricate from materials matching hall push-button stations, with text and graphics as required by authorities having jurisdiction, indicating that in case of fire, elevators are out of service and exits should be used instead. Provide one sign at each hall push-button station unless otherwise indicated.
- I. Data/Communications: Provide a minimum 8-pair of #18 conductors for communications systems.

## **2.10 FINISH MATERIALS**

- A. Stainless-Steel Sheet: ASTM A240/A240M, Type 304.
- B. Stainless-Steel Bars: ASTM A276, Type 304.
- C. Stainless-Steel Tubing: ASTM A554, Grade MT 304.
- D. Aluminum Extrusions: ASTM B221, Alloy 6063.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Examine hoistways, hoistway openings, and pits as constructed; verify critical dimensions; and examine supporting structure and other conditions under which elevator work is to be installed.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Comply with manufacturer's written instructions.
- B. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS standards for workmanship and for qualifications of welding operators.
- C. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.
- D. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.
- E. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
- F. Leveling Tolerance: 1/8 inch, up or down, regardless of load and travel direction.

- G. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
- H. Locate hall signal equipment for elevators as follows unless otherwise indicated:
  - 1. Mount hall lanterns at a minimum of 72 inches above finished floor.

### **3.3 FIELD QUALITY CONTROL**

- A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies.
- B. Operating Test: Load elevator to rated capacity and operate continuously for 30 minutes over full travel distance, stopping at each level and proceeding immediately to the next. Record temperature rise of elevator machine during 30-minute test period. Record failure to perform as required.
- C. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.

### **3.4 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 strippable protective film on entrance and car doors and frames.
  - 3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
  - 4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
  - 5. Do not load elevators beyond their rated weight capacity.
  - 6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
  - 7. 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.

### **3.5 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate, adjust, and maintain elevator(s).
- B. Check operation of elevator with Owner's personnel present before date of Substantial Completion and again not more than one month before end of warranty period. Determine that operation systems and devices are functioning properly.

### **3.6 MAINTENANCE SERVICE**

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include twelve months' full maintenance 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. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  - 1. Perform maintenance during normal working hours.

2. Perform emergency callback service during normal working hours with response time of two hours or less.
3. Include 24-hour-per-day, 7-day-per-week emergency callback service with response time of two hours or less.

**END OF SECTION 14 21 23.16**



## **SECTION 20 00 00 - COMMON MECHANICAL/ELECTRICAL REQUIREMENTS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Some paragraphs in this Section mirror similar paragraphs in Division 01; but those in this section are specific to the mechanical and electrical trades. Contractor shall comply with Division 01 as well as those requirements of this Division that are additional to or more stringent than those in Division 01.
- C. This section shall apply to the following Divisions:
  - 1. Division 21 - Fire Suppression
  - 2. Division 22 - Plumbing
  - 3. Division 23 - Heating, Ventilating, and Air Conditioning (HVAC)
  - 4. Division 26 - Electrical
  - 5. Division 27 - Communications
  - 6. Division 28 - Electronic Safety and Security

#### **1.2 SUMMARY**

- A. Give notices, file plans, obtain permits and licenses, pay fees and back charges, and obtain necessary approvals from authorities that have jurisdiction.
- B. Schedule the submittals of MEP and Fire Protection information required for the occupancy permit with enough time for resubmittal and approval. The required information is listed in Part 3, paragraph "MEP and Fire Protection Completion Requirements".
- C. Completely coordinate work of this Division with work of others and provide a complete and fully functional installation.
- D. Drawings and Specifications form complimentary requirements. Provide work specified and not shown, work shown and not specified as though explicitly required by both. Although work is not specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials for a sound, secure and complete installation

#### **1.3 DEFINITIONS**

- A. As used in all Sections covered by Division 20, "provide" means "furnish and install." "Furnish" means "to purchase and deliver to the project site complete with every necessary appurtenance and support," and "Install" means "to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project. "Architect" means the "Prime Design Consultant." If R.G. Vanderweil Engineers, LLP is not the Prime Design Consultant, the Architect may authorize R.G. Vanderweil Engineers, LLP to act on the Architect's behalf in matters concerning the systems Vanderweil has designed.
- B. The words "Architect" and "Engineer" may be used interchangeably in the mechanical and electrical Division specifications.

- C. The terms “Contractor,” “General Contractor,” “Construction Manager,” and “Design-Builder,” may appear in the mechanical and electrical Divisions. Wherever such a term is used, it shall mean the entity that is directing all the construction.
- D. A “substitution” means a product proposed by the Contractor that is from a manufacturer not listed in the individual sections of the Division 20 specifications as an “Acceptable Manufacturer.”
- E. “AHJ” means “Authorities Having Jurisdiction.”

#### **1.4 CONTRACT DOCUMENTS**

- A. The two dimensional drawings govern the construction. They show the design intent and are part of the Contract Documents. BIM models are not part of contract documents. They are developed for convenience only.
- B. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of an item in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.
- C. Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.
- D. Information and components shown on riser diagrams, but not shown on plans, and vice versa, shall apply or be provided as if expressly required on both.
- E. In spaces used by building occupants, but not in mechanical rooms, the architectural drawings shall govern the location of visible mechanical and electrical components. In order to obtain the intended aesthetics in such spaces, prior to installation of visible material and equipment (including access panels), review Architectural Drawings for desired locations and where not definitively indicated, request information from Architect.
- F. Maintain maximum headroom at all locations. All piping, duct, conduit, and associated components to be as tight to underside of structure as possible.
- G. Systems shall be run in a rectilinear fashion.
- H. Requirement for Complete Systems and Coordination Adjustments
  1. The two dimensional drawings and the BIM model are diagrammatic, whether furnished electronically or in hard copy. They indicate general arrangements of mechanical systems and other work, and are intended to convey sufficient information for skilled contractors and tradesmen to furnish and install complete systems. They are not intended to be absolutely precise; they are not intended to specify or to show every offset, fitting, and component. The purpose of the drawings and BIM model is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Based on the systems concept, the main components, and the approximate geometrical relationships, provide all other components and materials to make the systems fully complete, coordinated with other systems and the structure and space available, and operational.
  2. The drawings and BIM model are not designed to the level of detail of contractor’s or manufacturer’s fabrication drawings, shop drawings, sheet metal layout drawings, or coordination drawings.
  3. Certain information is specified and is intentionally not included on the drawings and BIM model such as hangers and supports, insulation, and routing of branch circuits. Provide installation in accordance with the specifications.
  4. Similarly, the drawings and BIM model do not show all offsets required for coordination nor do they show the exact routings and locations needed to coordinate with structure and other trades in order to avoid interferences and to meet ceiling heights and other Architectural

requirements. Establish and provide offsets, changes in direction, and exact routings to coordinate all systems.

5. Where conflicts or potential conflicts exist and engineering guidance is desired, submit a "Request for Information" (RFI).

## **1.5 DISCREPANCIES IN DOCUMENTS**

- A. Where Drawings or Specifications conflict or are unclear, submit clarification request in writing before Award of Contract. Otherwise, Architect's interpretation of Contract Documents shall be final, and no additional compensation shall be permitted due to discrepancies or un-clarities thus resolved.
- B. Where Drawings or Specifications do not coincide with manufacturers' recommendations or with applicable codes and standards, submit clarification request in form of an RFI before installation. Otherwise, make changes in installed work required for compliance with manufacturer instructions or codes and standards within Contract Price.
- C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specs, provide material, installation or work that is of the higher standard.
- D. Provide systems and components that are fully complete and operational and fully suitable for the intended use. Where insufficient information exists in the documents to precisely describe a certain component or subsystem, or the routing of a component or its coordination with other building elements, where notification required by Paragraph (A) above has not been submitted, provide the specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed in accordance with the design intent.
- E. In cases covered by Paragraph (D) above, where the contractor believes engineering guidance is needed, submit an RFI.
- F. Where discrepancies exist between the mechanical, plumbing, fire protection, and electrical drawings in regards to what trade owns disconnects or starters, the discrepancy shall be brought to the Architect's attention in accordance with paragraph (A) above. If the scope is not resolved prior to the Award of Contract, Division 26 shall provide such items.

## **1.6 CLASH DETECTION**

- A. Coordination drawings are specified in the paragraph titled Coordination Drawings. These are required whether engineering drawings have been produced from 2-D or 3-D models. In the latter case, the Contractor may use a BIM model to perform a clash detection study, and subsequently to work out the significant clashes and update the model, and use this as the basis for coordination drawings. The engineer will provide his BIM model for the contractor's use for this purpose if the contractor so requests and signs the appropriate release.
- B. The great majority of clashes in a BIM model involve non-clashing adjacencies or interferences of small MEP components, like piping 2 inches or less in diameter (excluding insulation). Such clashes shall be worked out by the contractor as part of his coordination effort. If a clash consists of a major routing or other impasse, upon submittal of an RFI, the engineer will provide guidance.

## **1.7 REQUESTS FOR INFORMATION (RFI'S)**

- A. Where an RFI is a request to resolve a conflict or an un-clarity, or a request for additional detail, contractor's RFI shall include a sketch or equivalent description of contractor's proposed solution.

- B. To expedite the processing of RFIs, submit the attached form, or similar form including the same information to the Architect, with a copy to the Engineer. Include Contractor proposed solution, with sketches as required, in the indicated space on the form.
- C. The form and all RFI related documents shall be submitted as one PDF (non-binder) format file, without password protection. If it is impossible to convert some information to PDF, it may be submitted as a second file, not password protected.

RFI FORM

RFI No. \_\_\_\_\_

Date Submitted \_\_\_\_\_ :

Contractor:

Date Required: \_\_\_\_\_

Job Name: \_\_\_\_\_

Person: \_\_\_\_\_

Spec. Sec./Dwg. No.: \_\_\_\_\_

Contr. Fax No.:

Vanderweil Fax No.: \_\_\_\_\_ (617) 423-7401

Arch. Fax No.: \_\_\_\_\_

Contractor Field Question (Provide narrative and/or sketch):

Contractor Proposed Solution (Provide narrative and/or sketch):

Vanderweil Response:

## 1.8 COORDINATION DRAWINGS AND COORDINATION MODEL

- A. Coordination drawings are required for all Divisions covered by this Section. These drawings require information on all mechanical and electrical trades. The content and procedures described in Division 01 shall be followed, with the additional requirements specifically for the mechanical and electrical trades as described in this Section. If a BIM model is not used on this project, the below requirements shall be accomplished in CAD.
- B. The main paths of egress and for equipment removal from main mechanical and electrical rooms shall be clearly shown on the coordination drawings.
- C. The initiation of these drawings begins with the Sheet Metal Subcontractor's BIM model and the resultant sheet metal shop drawings.
- D. The Sheet Metal Subcontractor's BIM model shall incorporate the sheet metal as well as structure and other information for spatial coordination. Provide cross sections in congested areas. Access panels shall be shown, as well as all fire walls and smoke partitions, which shall be shown in a different color than the regular partitions and the sheet metal.
- E. Each of the mechanical, electrical and other specialty trades shall electronically add its work to the model in a separate color, with appropriate offsets, elevations and grid dimensions, and showing access panels. Mechanical, electrical, and specialty trade information is required for fan rooms and mechanical rooms, horizontal exits from duct shafts, crossovers, and for spaces in and above ceilings. Drawings shall indicate horizontal and vertical dimensions to avoid interference with structural framing, ceilings, partitions, and other services.
- F. The following shall be submitted to the Engineer for review:
  - 1. The 3-D electronic model showing all trades and color coded by trade.
  - 2. For HVAC review:
    - a. An electronic set of 2-D PDFs of all floor plans and sections, made from the 3-D electronic model showing all trades color coordinated.
    - b. An electronic set of 2-D PDFs of all floor plans, made from the 3-D electronic model, but showing only the HVAC superimposed on the architectural layout.
  - 3. For electrical review:
    - a. An electronic set of 2-D PDFs of all floor plans and sections, made from the 3-D electronic model showing all trades color coordinated.
    - b. An electronic set of 2-D PDFs of all floor plans, made from the 3-D electronic model, but showing only the electrical superimposed on the architectural layout.
  - 4. For plumbing review:
    - a. An electronic set of 2-D PDFs of all floor plans and sections, made from the 3-D electronic model showing all trades color coordinated.
    - b. An electronic set of 2-D PDFs of all floor plans, made from the 3-D electronic model, but showing only the plumbing superimposed on the architectural layout.
  - 5. For fire protection review:
    - a. An electronic set of 2-D PDFs of all floor plans and sections, made from the 3-D electronic model showing all trades color coordinated.
    - b. An electronic set of 2-D PDFs of all floor plans, made from the 3-D electronic model, but showing only the fire protection superimposed on the architectural layout.
  - 6. One complete set of 2-D coordination drawings, printed out full size with individual trades superimposed and color coded.
- G. The 2-D PDFs are considered the coordination drawings. The engineering review is based on these, not on the 3-D model, which the engineer may need to refer to for clarification in congested spaces.

- H. Fabrication shall not start until the coordinated model, PDF's, and prints are received by the Engineer and have been reviewed.
- I. Review by Engineer of coordination drawings is limited to confirming that requirements for coordination and preparation of plans have been complied with by the Contractor and shall not diminish responsibility under this Contract for final coordination of installation and maintenance clearances of all systems and equipment with Architectural, Structural, Mechanical, Electrical and other related work.
- J. After Review:
  - 1. The Engineer will provide comments.
  - 2. All changes to reviewed coordination drawings shall be approved in writing by the Architect prior to start of work in affected area.
- K. Coordination Drawings shall include, but are not limited to:
  - 1. Plumbing systems, piping and equipment.
  - 2. HVAC piping, systems and equipment.
  - 3. Control systems.
  - 4. Electrical distribution, systems and equipment.
  - 5. Lighting systems and fixtures.
  - 6. Sheet metal work, components and accessories (e.g. coils, terminal boxes).
  - 7. Fire protection and sprinkler system, piping and heads.
  - 8. Structural.
  - 9. Electrical Equipment Room layouts.
  - 10. Environmental Rooms and associated refrigeration/heating systems.
  - 11. Partition/room layout.
  - 12. Ceiling tile and grid
  - 13. Access panels.
  - 14. Smoke and fire dampers.
  - 15. Roof drain piping.
  - 16. Major electrical conduit runs, panel boards, feeder conduit and racks of branch conduit.
  - 17. Above ceiling miscellaneous metal.
  - 18. Heat tracing of piping.

## **1.9 ENGINEER'S ELECTRONIC BIM FILES**

- A. Electronic BIM files for Fire Protection, Plumbing, HVAC, Electrical, Communication, or Electronic Safety and Security drawings will be furnished by Engineer at contractor's request. These files will be provided on Engineer's FTP site in the software release used by the Engineer. If other media or software version is requested, Engineer will require advance reimbursement of processing costs.
- B. Requests should be made by filling out the following form letter and providing an authorized signature. The requested information will not be released prior to receipt of this letter for the appropriate documents.

[DATE]

R.G. Vanderweil Engineers, LLP  
Attn: [NAME]  
[ADDRESS]

Re: [JOB NAME]

Dear [NAME]:

We hereby request that you provide us with the following electronic files:

[ELECTRONIC FILE Name, date of file, description]

R.G. Vanderweil Engineers, LLP (“Vanderweil”) agrees to provide the above-referenced electronic files to [ ] (the “Recipient.”). Recipient recognizes that data recorded on or transmitted as electronic files are subject to undetectable alteration, either intentional or unintentional, due to among other causes, transmission, conversion, media degradation, software error, or human alteration. Accordingly, the electronic files are provided to Recipient for informational purposes only and not as an end product or Contract Document.

Vanderweil makes no warranties, either express or implied, regarding the fitness or suitability of the electronic files. The electronic files are instruments of professional service, and shall not be used, in whole or in part, for any project other than that for which they were created, without the express written consent of Vanderweil Engineers.

Accordingly, Recipient agrees to waive any and all claims against Vanderweil resulting in any way from the use, unauthorized reuse or alteration, or misuse of the electronic files, and to defend, indemnify and hold Vanderweil harmless from any claims, losses, damages, or costs, including attorney’s fees, arising out of the use, reuse, alteration, or misuse of the electronic files.

Further:

1. Recipient agrees that any electronic/model data provided in the Electronic Files is for reference only and does not relieve the contractor and subcontractors from the responsibility for material take offs and cost estimations, coordination of systems, sequencing, and means and methods.
2. Recipient agrees not to sell, assign or lease any rights in the designs, models, drawings, information and depicted works in any form to any person or entity.
3. Recipient agrees not to remove any copyright notices, labels or marks on the designs, drawings, information and depicted works.
4. Under no circumstances shall the transfer of ownership of electronic data, or hard copy thereof, be deemed to be a sale by Vanderweil of tangible goods, and Vanderweil makes no warranties, express or implied, of merchantability or of fitness for a particular purpose.
5. The Electronic Files issued are current as of the date of the last revisions as imbedded in the files. Vanderweil is not responsible or liable for providing any updates or modifications that may or may not have occurred since the revision dates shown in the files. The Electronic Files may also represent only a portion - not a complete set - of the construction documents or model data and, as such, they may be incomplete or inconsistent with the most recent design. Vanderweil makes no representation as to its completeness, currency or accuracy and Vanderweil shall not be responsible to advise the Recipient of any changes which may hereafter be made to the Project plan or configuration or other information contained in the Electronic Files.



6. Recipient acknowledges that the designs, drawings, information and depicted works are protected by copyright laws, and that Vanderweil, or its Consultants, as appropriate, is the author and/or owner of same.
7. Vanderweil, or its Consultants, as appropriate, retains all copyrights to the designs, drawings, information and depicted works on the disk and grants to Recipient a limited license to reproduce such information in connection with Recipient or their contractors' or subcontractors work on the Project, and no other.
8. If specifications are provided, recipient agrees not to modify same.
9. If BIM models are provided, the following shall apply:
  - Contract Documents Govern the Project. Recipient agrees that, notwithstanding the use of BIM technology and the transfer of BIM Data, the specifications, and the 2-dimensional Contract Documents and subsequently issued Change Orders, Change Directives, Bulletins, RFI Responses and the like are the sole source of information regarding the requirements for construction of the Project. Recipient will notify Vanderweil if it becomes aware of discrepancy between the BIM Data and any drawing, specification or other document issued for construction of the Project.
  - BIM (i.e. Revit/Navisworks) models and associated files will only contain elements and content that Vanderweil Engineers deems necessary and as required to produce the two dimensional drawings that govern the project. No specific Level of Detail (LOD) is implied or expected. The Recipient agrees that no Revit families or Revit content shall be removed from the model and/or used for any other purpose than supporting this specific project.
  - The BIM model is for general informational and reference purposes only, and is not to be used by the contractor as an alternative to performing field measurements, preparing coordination drawings, or developing shop drawings. Access to the BIM model does not relieve the contractor of the contractual responsibility to implement the design intent through various means. These means include verifying existing conditions, producing coordination drawings (compiled from various sub-contractors), preparing shop drawings, and controlling means and methods of construction.

#### **1.10 RELATED WORK IN OTHER SECTIONS**

- A. The following work is not included and shall be performed under other Sections. Coordinate requirements with other Divisions.
  1. Excavation and backfill.
  2. Concrete work, including concrete housekeeping pads and other pads and blocks for vibrating and rotating equipment, and cast in place manholes and handholes.
  3. Cutting and patching of masonry, concrete, tile and other parts of structure, with the exception of drilling for hangers and providing holes and openings in metal decks.
  4. Flashing of wall and roof penetrations.
  5. Installation of access panels in floors, walls, furred spaces or above ceilings.
  6. Painting, except as specified herein.
  7. Structural supports necessary to distribute loading from equipment to roof or floor except as specified herein.
  8. Temporary light, power, water, heat, gas and sanitary facilities for use during construction and testing.
  9. Outdoor air intake and exhaust louvers.
  10. Wall and ceiling enclosures and shafts for supply, return and exhaust ductwork as shown on drawings.
- B. Installation of circuit breakers (furnished by ATC Contractor) and final electrical panel terminal connections for ATC control power wiring shall be provided by Division 26.
- C. Electric power wiring for all equipment shall be provided by Division 26.

## **1.11 SITE VISIT**

- A. Before submitting bid, visit and carefully examine site to identify existing conditions and difficulties that will affect work of this Section. No extra payment will be allowed for additional work caused by unfamiliarity with site conditions that are visible or readily construed by an experienced observer.

## **1.12 EXISTING CONDITIONS AND PREPARATORY WORK**

- A. Before starting work in a particular area of the project, visit the location and examine conditions under which work must be performed including preparatory work done under other Sections or other Contracts or by the Owner. Review geometrical constraints, such as ceiling heights, to ensure constructability and access for maintenance. Report conditions that might adversely affect work in writing to the Architect. Do not proceed with work until defects have been corrected and conditions are satisfactory. Commencement of work shall be construed as complete acceptance of existing conditions and preparatory work.
- B. Existing Concrete Slabs. Before coring or other penetration of existing slabs, scan the area where the work is to be performed in order to locate existing in-slab or below-slab utilities, and position the slab penetrations so as to avoid these.

## **1.13 CODES, STANDARDS, AUTHORITIES AND PERMITS**

- A. Perform work in accordance with rules, regulations, standards, codes, ordinances, and laws of local, state, and Federal governments, and other authorities that have legal jurisdiction over the site.
- B. Secure and pay for all permits and inspections required by the Authorities having Jurisdiction. Secure trade permits prior to beginning work.
- C. Materials and equipment shall be manufactured, installed and tested as specified in latest editions of applicable publications, standards, rulings and determinations of:
  - 1. Applicable local and state codes.
  - 2. National Fire Protection Association (NFPA).
  - 3. American Insurance Association (AIA) (formerly National Board of Fire Underwriters).
  - 4. Occupational Safety and Health Act (OSHA).
  - 5. Underwriters Laboratories (UL)
  - 6. Factory Mutual Association (FM)
  - 7. Owner's Insurance Underwriter.
- D. Specific reference is made to the following NFPA standards which contain an exceptionally high quantity of mechanical, electrical, and fire protection requirements. These standards as referenced by the applicable building, fire, and mechanical codes shall apply.
  - 1. No. 13 - Installation of Sprinkler Systems
  - 2. No. 14 - Installation of Standpipe and Hose Systems
  - 3. No. 20 - Installation of Centrifugal Fire Pumps
  - 4. No. 30 - Combustible Liquids
  - 5. No. 37 - Installation of Use of Stationary Combustion Engines and Gas Turbines
  - 6. No. 70 - National Electric Code
  - 7. No. 72 - National Fire Alarm Code
  - 8. No. 101 - Life Safety Code
- E. Material and equipment shall be listed by Underwriters' Laboratories (UL).
- F. When requirements cited in the various parts of the Contract Documents conflict with each other, most stringent shall govern work. Architect may relax this requirement when relaxation does not violate ruling of AHJ. Approval for relaxation shall be obtained from AHJ in writing.

- G. Unless indicated otherwise, the most recent editions of applicable specifications and publications of the following organizations form part of these Contract Documents. Material and Equipment shall be approved by the relevant organizations for intended service.
1. American National Standards Institute (ANSI).
  2. American Society of Mechanical Engineers (ASME).
  3. National Electric Manufacturers Association (NEMA).
  4. American Society for Testing and Materials (ASTM).
  5. American Water Works Association (AWWA).
  6. American Society for Heating, Refrigerating and Air Conditioning Engineers (ASHRAE).
  7. Air Moving and Conditioning Association (AMCA).
  8. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).
  9. Air Conditioning and Refrigeration Institute (ARI).
  10. Thermal Insulation Manufacturers Association (TIMA).
  11. Institute of Electrical and Electronics Engineers (IEEE).
  12. Insulated Cable Engineers Association (ICEA).
  13. Manufacturer's Standardization Society of the Valve & Fittings Industry (MSS)

#### **1.14 WARRANTY AND 24 HOUR SERVICE**

- A. This Paragraph shall not be interpreted to limit Owner's rights under applicable codes and laws and under this Contract.
- B. Part 2 paragraphs of all specification Sections may specify warranty requirements that exceed those of this Paragraph.
- C. Warranty the Work of this Section in writing for one year following the date of Substantial Completion. If the equipment is used for ventilation, temporary heat, or other use prior to initial beneficial occupancy by the Owner, the bid price shall include an extended period of warranty covering the one-year of beneficial occupancy by the Owner. The warranty shall be to repair or replace defective products, materials, equipment, workmanship and installation that develop within this period promptly and to Architect's satisfaction, and to correct damage caused in making necessary repairs and replacements under warranty within Contract Price.
- D. In addition to warranty requirements of Division 01 and of Paragraph C above, obtain written equipment and material warranties offered in manufacturer's published data, without exclusion or limitation, in Owner's name.
- E. Replace material and equipment that require excessive service during warranty period. Excessive service shall be defined as more than three service calls for the same material or equipment within a 12 month period.
- F. Provide 24-hour service beginning on the date of Substantial Completion and lasting until the termination of the warranty period. Service may be provided by a separate service organization subject to Owner approval. Submit name and a phone number that will be answered on a 24-hour basis each day of the week, for the duration of the service.
- G. Submit copies of equipment and material warranties before final payment.
- H. Use of systems provided under this Section for temporary services and facilities shall NOT constitute Final Acceptance of work nor beneficial use by Owner, and shall not institute warranty period.
- I. Provide manufacturer's engineering and technical staff at site to analyze and rectify problems that develop during warranty period immediately. If problems cannot be rectified immediately to Owner's satisfaction, advise Architect in writing, describe efforts to rectify situation, and provide analysis of cause of problem. Architect will recommend course of action.

## **1.15 ACCEPTABLE MANUFACTURERS**

- A. Acceptable Manufacturers: The Engineer's design for each product is based on the single manufacturer listed in the schedule or shown on the drawings. In Part 2 of the individual Specification Sections certain Alternate Manufacturers may be listed as being acceptable. These are acceptable only if, as a minimum, they are in compliance with the following requirements:
1. Meet all performance criteria listed in the schedules and outlined in the specification. For example, to be acceptable, an air handling unit must deliver equal CFM against equal external static pressure using equal or less horsepower as the air handler listed in the schedules.
  2. Have identical operating characteristics to those called for in the specification. For example, a reciprocating compressor will not be acceptable if a rotary model is specified.
  3. Fit within the available space it was designed for, including space for maintenance and component removal, with no modification to either the space or the product. Clearances to walls, ceilings and other equipment will be at least equal to those shown on the design drawings. The fact that a manufacturer's name appears as acceptable shall not be taken to mean that the Architect has determined that the manufacturer's products will fit within the available space - this determination is solely the responsibility of the contractor.
  4. For rooftop mounted equipment and for equipment mounted in areas where structural matters are a consideration, the products must have a weight no greater than the product listed in the schedules or specifications.
  5. Products must adhere to all architectural considerations including, but not limited to: being of the same color as the product scheduled or specified, fitting within architectural enclosures and details, and for diffusers and plumbing fixtures - being the same size and of the same physical appearance as scheduled for specified products.

## **1.16 DEVIATIONS**

- A. Proposed deviations from Contract Documents shall be requested individually in writing whether deviations result from field conditions, standard shop practice, or other cause. Submit letter with transmittal of Shop Drawings which flags the deviation to the attention of the Architect.
- B. Without letters flagging the deviation to the Architect, it is possible that the Architect may not notice such deviation or may not realize its ramifications. Therefore, if such letter are not submitted to the Architect, the Contractor shall hold the Architect and his consultants harmless for any and all adverse consequences resulting from deviations being implemented. This shall apply regardless of whether the Architect has reviewed or approved shop drawings containing the deviation, and will be strictly enforced.
- C. Approval of proposed deviations, if any, will be made at discretion of the Architect.

## **1.17 SUBMITTALS**

- A. This Paragraph supplements Division 01.
- B. Besides shop drawings, which are submitted relatively early in the project, code-required information on life safety and other systems is required to be submitted prior to claiming construction completion and filing for an occupancy permit. Refer to Part 3 of these specifications.
- C. Definitions
1. Submittals include product data, shop drawings, coordination drawings, and sheet metal shop drawings. Product data and shop drawings are information prepared to illustrate, in more detail than shown on the contract documents, the fixtures, equipment and other components of the work as proposed by the contractor. These are action submittals.
  2. Coordination Drawings are detailed, large-scale layout Shop Drawings showing HVAC, Electrical, Plumbing and Fire Protection work superimposed in order to identify conflicts,

ensure inter-coordination of Mechanical, Electrical, Plumbing, Architectural, Structural and other work, and to conform the engineering layouts to best construction practices. Coordination drawings are information submittals.

3. Sheet Metal Shop Drawings are 3/8 inch scale detailed sheet metal layouts showing all offsets, fittings, and hangers and supports, and other appurtenances. These are information submittals.
4. Electronic Copy means copy in a searchable PDF format, and excludes scanned material and faxed material. Scanned material and faxed material shall not be submitted.

D. Submittal Cover Sheet

1. In addition to the information required for all submittals on the project as specified in Division 01, provide the below special cover sheet for submittals falling within Division 20, 21, 22, 23, 26, 27 and 28. Information on the special cover sheet shall be completely filled out. Submit a separate cover sheet with shop drawings for each section of the specifications.
2. Where the section specifies a class of products (for example, plumbing fixtures, wiring devices, insulation) the submission for that section shall either be complete, including all products within that class or it shall contain an index listing all products within that class and designating which ones are included with that submittal. Where the submission covers more than one product, the information required on the cover sheet shall be clearly differentiated by product if it does not apply in common for all included products.

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SUBMITTAL COVER SHEET

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PROJECT: \_\_\_\_\_ DATE: \_\_\_\_\_

DIVISION NO. \_\_\_\_\_ SECTION NO. \_\_\_\_\_ PARA. NO. \_\_\_\_\_

DESCRIPTION: \_\_\_\_\_

CONTRACTOR: \_\_\_\_\_

CONTRACT DRAWING REFERENCE NO: \_\_\_\_\_

EQUIPMENT TAG (From Dwg. Schedules): \_\_\_\_\_

SUBMISSION (check one):  First  Second  Third  Fourth

INFORMATION AND CHECKLIST

1. Direct contact information for product representative or supplier to which questions can be referred (name, address, phone number, and email address).

Name: \_\_\_\_\_

Address: \_\_\_\_\_

Phone Number: \_\_\_\_\_ Email: \_\_\_\_\_

				<u>Comment</u>
2.	Are all specified or scheduled items included and exactly match scheduled/specified items?	Yes	No	
3.	Is this item a substitution or other deviation? If so, follow procedures in Section 01 25 00.	Yes	No	
4.	Does equipment fit space shown on construction documents, coordination drawings, and actual field conditions?	Yes	No	
5.	Does this material/equipment add expense to other trades or project costs?	Yes	No	
6.	Is control interface coordinated?	Yes	No	
7.	List electrical characteristics (Voltage/Phase/Hz/Amps)			

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E. Submittal Contents, Format, Procedures

1. For the submittals covered by Division 20, Contractor review of submittals is intended to ensure that the submittals include the foregoing cover sheet, are in the correct electronic or paper format as specified below, and that the specified item physically fits into the space available. Contractor shall verify that the submittal contains adequate information to verify specification requirements as well as the performance and dimensional requirements shown on the drawings.
2. HVAC controls shall be coordinated with any package controls provided with equipment to ensure that the HVAC controls submittal includes all required sequences.
3. Submittal Contents
  - a. Submittals shall be comprehensive and fully self-contained.
  - b. Submittals shall include page numbers to allow reviewer to identify specific location where comment applies.
  - c. Electronic submittals shall be fully self-contained and shall not contain links to associated websites. The submittal coversheet, transmittal, and document shall be prepared as one searchable PDF (non-binder) format file, without password protection. If it is not possible to convert some material into PDF, it is acceptable to submit this as a second file.
  - d. Submittals shall include all catalog data and physical and performance characteristics and plans and diagrams as necessary to confirm compliance with plans and specifications.
  - e. Submittals shall contain only information relevant to the particular equipment or materials to be furnished. Clearly indicate the piece of equipment or material being provided. Do not submit generic catalog cuts which describe several different items in addition to those specific items being provided, unless all irrelevant information is marked out or relevant information is clearly differentiated. Those items and features that are not being proposed for this project shall be crossed out so as not to imply that they are included.
  - f. Where applicable, equipment Product Data shall include wiring and interlock diagrams using the standard wiring diagrams with all terminals, which have been provided for use by the various Subcontractors clearly indicated. For example, remote start/stop wiring from BMS system to a motor control center shall be clearly identified.
  - g. Provide shop drawing submittals showing details of piping connections to ALL equipment. If connection details are not submitted and connections are installed incorrectly in the field, reinstall within the original contract price.
  - h. Division 23 shop drawings and installation layout drawings for heating, pumping, process piping, and refrigeration systems prepared by the Installer shall note name(s), license number(s), and license expiration dates of the installing firm.
  - i. Submit the following for review, including a submittal cover sheet for each product:
    - 1) Electronic copy (see above requirements for electronic copy) for each submittal.

F. Sheet Metal Shop Drawings

1. The Sheet Metal Subcontractor shall prepare a complete electronic background model in a current version of AutoCAD, REVIT, or Navisworks. Request for use of an alternative software shall be submitted to the Architect for approval before preparation of shop drawings. This background shall be used to develop sheet metal shop drawings. Electronic copy of these shall be submitted, containing sufficient plans, elevations, sections, details and schematics to describe work clearly. Plans shall be 3/8 inch = 1 foot-0 inches scale and shall indicate work of other Sections where physical clearances are critical and where interferences are possible. Provide larger scale details to show complete installation. Sheet metal drawings shall show elements of Architect's reflected ceiling plan, exposed ductwork, walls, partitions, diffusers, registers, grilles, fire dampers, sleeves and other aspects of construction for coordination. Show horizontal and vertical offsets and changes of direction. Show all firewalls and smoke partitions. These are action submittals.

2. These shop drawings shall be submitted before the coordination drawings are prepared, and once the Architect's comments are received back shall serve as the starting point for coordination drawings as specified above.

G. Post-Submittal Actions

1. After review, Contractor to receive electronically transmitted response report for all reviewed submittals which includes the following information:
  - a. Submittal status
  - b. List of reviewer's comments
  - c. Copy of returned submittal. All submittals will be returned electronically, with the exception of coordination drawings, which will have one copy returned with comments through overnight mail.
  - d. Re-submittals shall be complete and shall include a cover letter summarizing the corrections made in response to the review comments and the submittal page numbers which were revised.
  - e. Submittal Status: Electronic and paper submittals will be returned notated as illustrated below:

"APPROVED AS NOTED"

"Reviewed and found generally acceptable. Minor deviations may be noted. No further submittal required if notations are complied with."

"REJECTED"

Submittal is incorrect to such an extent that material is unacceptable, or is incomplete to such an extent that a complete review cannot be made. Resubmit in accordance with requirements of the Contract Documents."

"NO ACTION"

Submittal not reviewed.

"REVIEWED FOR INFORMATION"

This Submittal is for information only.

2. Where initial submittal is rejected, revised submittal shall be labelled identically to previous submittal and shall include a memo identifying where each comment has been address in the new version.

H. Responsibility

1. Intent of Architect's submittal review is to check for capacity, rating, and certain construction features. Contractor shall ensure that work meets requirements of Contract Documents regarding information that pertains to fabrication processes or means, methods, techniques, sequences and procedures of construction; and for coordination of work of this and other Sections. Work shall comply with submittals marked "APPROVED AS NOTED" to extent that they agree with Contract Documents. Submittal review shall not diminish responsibility under this Contract for dimensional coordination, quantities, installation, wiring, supports and access for service, nor shop drawing errors or deviations from requirements of Contract Documents. Noting of some errors while overlooking others will not excuse proceeding in error. Contract Documents requirements are not limited, waived nor superseded by review.
2. Inform Subcontractors, Manufacturers and Suppliers of scope and limited nature of review process and enforce compliance with contract documents.

- I. Schedule: Incorporate shop drawing review period into construction schedule so that Work is not delayed. Contractor shall assume full responsibility for delays caused by not incorporating the following shop drawing review time requirements into his project schedule. Working days listed refer to the time in the Engineer's office. It does not include transmittal or review time of others.



Unless longer review periods are specified in Division 01, allow at least 10 working days, exclusive of transmittal time, for review each time shop drawing is submitted or resubmitted for Divisions covered by this Section, with the exception that 20 working days, exclusive of transmittal time, are required for the following:

1. HVAC temperature control submittals.
2. HVAC balancing report.
3. Coordination Drawings.
4. Distribution equipment including Panelboards.
5. Short circuit and coordination study
6. Fire protection fabrication drawings.
7. If more than five shop drawings of a single trade are received in one calendar week.

#### **1.18 RECORD DRAWINGS AND PHOTOS**

- A. The photos called for in this paragraph are in addition to those required in Division 01 (the latter are general construction progress/status photos). The photos required here are specifically for the mechanical and electrical trades in concealed areas and shall be included in the base contract(s) for these trades.
- B. As work progresses and for duration of Contract, maintain complete and separate set of prints of Contract Drawings at job site at all times. Record work completed and all changes from original Contract Drawings. Such changes shall include, but not be limited to, those resulting from RFIs, field conditions, and modifications and additions. Include actual locations of MEP/FP systems and existing and new utilities. Record valve tags as they are installed.
- C. Photos. Take photographs of all concealed systems and equipment in inaccessible ceilings, shafts, underground (buried) piping routes and other concealed, not readily-accessible areas. At completion of work, make copies of photographs with written explanation on back, or, at Architect's request, submit digitally. These are information submittals.
- D. Underground and utility work shall be located by distances to landmarks, such as building foundations. Give actual dimensions of everything installed including elevations and elevations at each change in direction.
- E. Drawings shall show record condition of details, sections, riser diagrams, control changes and corrections to schedules. Schedules shall show actual manufacturer and make and model numbers of final equipment installation.
- F. "Record Drawings" are a complete set of drawings containing the information in (B), (D) and (E) above, and shall be accompanied by the photographs in (C) above. If BIM is used to create the record drawings, the model shall incorporate all the above information and be developed to AIA LOD 500.
- G. The installing Contractor shall certify Record Drawings for accuracy. The Architect/Engineer will not certify the accuracy of the record drawings - this is the sole responsibility of the Contractor.
- H. If required by the Authority having jurisdiction, each trade shall submit a set of record drawings for approval by the Authority. Format for submission shall be acceptable to the Authority. Drawing format and size changes, and supplemental information required for the submittal are the responsibility of the installing contractor. Provide copies of submittal to the Construction Manager, General Contractor, Owner, Architect, and Engineer.
- I. At completion of work, prepare a complete set of record drawings with all markups incorporated in electronic format. Deliver these to the Architect for approval. Vanderweil can provide 2-D CAD drawings of its BIM model to the contractor to serve as the basis for the electronic format drawings, upon signing of a release.

- J. After approval, final record drawing deliverable shall be as defined in Division 01. After approval, final record drawings submitted shall be as required by Division 01.

#### **1.19 OPERATING AND MAINTENANCE MANUALS – ELECTRONIC FORMAT**

- A. Section 01 78 23 describes requirements for Operating and Maintenance Manuals, and Section 01 79 00 describes requirements for training and operating instructions. This section includes additional requirements specifically for the mechanical and electrical trades.
- B. “Electronic Format” means searchable PDF format. It does not include scanned items, which are considered inappropriate.
- C. Obtain at time of purchase of equipment, electronically formatted versions of operation, lubrication, and maintenance manuals for all items. Assemble this literature along with other information in coordinated electronic manuals with additional information describing combined operation of field assembled units, including as-built wiring diagrams. Manual shall contain names and addresses of manufacturers and local representatives who stock or furnish repair parts for items or equipment. Divide manuals into three sections or books as follows:
  - 1. Engineering flow diagrams and controls sequences from project mechanical drawings, approved automatic temperature controls submittal, equipment startup procedures and operational instructions. Startup and operational instructions shall list valves, switches, and other devices used to start, stop and control systems. Describe procedure to be followed in case of malfunctions. Include approved valve directory showing each valve number, location of each valve, and equipment or fixture controlled by valve.
  - 2. Detailed maintenance and troubleshooting manuals containing data furnished by manufacturer for complete maintenance. Include copy of balancing report.
  - 3. Lubrication instructions detailing type of lubricant, amount, and intervals recommended by manufacturer for each item of equipment. Include additional instructions necessary for implementation of first class lubrication program. Include approved summary of lubrication instructions in chart form, where appropriate.
- D. Submit electronic format version of manual(s) for approval. After approval, submit electronic version and one hard copy for distribution to Owner. Deliver manuals no less than 30 days prior to acceptance of equipment to permit Owner’s personnel to become familiar with equipment and operation prior to acceptance.

#### **1.20 OPERATING INSTRUCTION**

- A. Upon completion of installation, prior to Owner accepting portions of building and equipment for operational use, instruct Owner’s operating personnel in operation of systems and equipment. Instruction shall be performed by equipment and controls vendors’ factory-trained personnel. Owner shall determine which systems require additional instruction. Duration of instructions for controls shall take equipment through complete cycle of operation (at least five working days). (Not to be confused with the two-week demonstration of automatic controls operation specified in Part 3.) Make necessary adjustments under operating conditions.

### **PART 2 - PRODUCTS (NOT USED)**

### **PART 3 - EXECUTION**

#### **3.1 LIFE SAFETY SYSTEMS CERTIFICATION OF COMPLETION**

- A. Definitions

1. Life Safety Systems - Mechanical and electrical systems including:
  - a. Fire Suppression Systems
  - b. Fire Notification (Alarm) and Detection Systems
  - c. Egress Signage and Lighting Systems
  - d. Emergency Power Systems
2. Complete - For a system to be complete the following shall be true:
  - a. No further work is required to satisfy the requirements specified in the drawings, specifications and applicable codes and standards.
  - b. Systems are fully operational with power to components, valves open, status indicators in "normal" condition and otherwise ready "as-is" to perform required functions.
  - c. Required product data and shop drawing submittals have been submitted and returned with a "Reviewed" status. See Paragraph titled "Submittals" for submittal requirements.
  - d. Test certificates have been submitted and returned with a "Approved as Noted" status. See Paragraph titled "Submittals".
  - e. Project visit report observations and "punch list" items have been addressed and/or corrected.
  - f. "O&M" documentation and "as-built" plans have been submitted and returned with a "Reviewed" status.

**B. Notification of Completion**

1. Notify the Architect in writing that the life safety systems are complete at least five (5) working days prior to requesting final certification of completion ("affidavits") from the Architect. The notification shall be in the form of a single formal document endorsed by an individual charged with management responsibility for all trades associated with the life safety systems.
2. Schedule work so life safety systems are complete in advance of other systems. This requirement is to allow the Architect to conduct a final project visit and correction of issues found without affecting issuance of a Substantial Completion Certificate or a Certificate of Occupancy by the Authorities Having Jurisdiction.
3. Operate and maintain systems and equipment until final acceptance by the Owner and AHJ.
4. All guarantees and warranties shall not begin until final acceptance of the systems and equipment by the Owner and AHJ. Acceptance requires, at a minimum, completed systems testing and inspections.

**3.2 SPECIAL RESPONSIBILITIES**

**A. Cooperate and coordinate with work of other Sections in executing work of this Section.**

1. Perform work so that progress of entire project including work of other Sections shall not be interfered with or delayed.
2. Provide information requested on items furnished under one Section which shall be installed under other Sections.
3. For equipment provided under any division or section which has connection made under the mechanical or electrical sections, obtain detailed installation and hookup information from the equipment manufacturers.
4. Obtain final roughing dimensions or other information needed for complete installation of items furnished under other Sections or by Owner.
5. Keep fully informed as to shape, size and position of openings required for material or equipment to be provided under all Sections. Give full information so that openings required by work of this Section may be coordinated with other work and other openings and may be provided for in advance. In case of failure to provide sufficient information in proper time, provide cutting and patching or have same done, at own expense and to full satisfaction of Architect.
6. Provide information requested as to sizes, number and locations of concrete housekeeping pads necessary for floor-mounted vibrating and rotating equipment provided under this Section.

7. Notify Architect of location and extent of existing piping, conduit, ductwork and equipment that interferes with new construction. In coordination with and with approval of Architect, relocate piping, ductwork and equipment to permit new work to be provided. Remove non-functioning and abandoned piping, ductwork and equipment. Dispose of or store items.
- B. Building Expansion Joints and Firewalls
1. Ductwork, conduit, cable tray, piping, and other horizontal distribution systems shall be provided with expansion provisions when passing by building expansion joints. Provide copper ground jumper across expansion joints for electrical components. Systems shall be run through rated walls, partitions, and floors via approved fireproofed sleeves.
- C. Installation Shall Provide Access to Systems
1. Installation shall allow clearances for easy access to systems for routine maintenance, for repairs, and for installing new cable in conduit and cable trays.
  2. Access panels shall be installed in ceilings that are not composed of removable tiles. These shall be located where system components exist that have moving parts, motors, or other components requiring periodic maintenance, adjustment, or replacement. Access panels shall be shown on Coordination Drawings and shall be of the type and finish approved by the Architect.
- D. Protection of Work
1. Each contractor shall be responsible for work and equipment until finally inspected, tested, and accepted. Carefully store materials and equipment that is not immediately installed after delivery to site. Close open ends of work with temporary covers or plug during construction to prevent entry of obstructing material. Cover work subject to falling debris with temporary covers.
  2. Provide all materials, equipment and labor to provide adequate protection of all equipment during the course of construction. This includes protection from moisture and foreign material. At completion, all work must be turned over to Owner clean and in new condition.
  3. Protect the work and material of other trades that might be damaged by work or workmen and make good all damage thus caused.
- E. Installation Only Items
1. Where a Contractor is required to install items that it does not purchase, coordinate the delivery and be responsible for their unloading from delivery vehicles and for safe handling and field storage up to the time of installation.
    - a. Provide field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of dunnage supporting members and fastenings to adapt them to architectural and structural conditions.
    - b. Provide connection to building systems including the purchase and installation of terminating fittings necessary to adapt and connect them to the building systems.
  2. Carefully examine items upon delivery. Claims that items have been received in a condition that their installation will require procedures beyond the scope of work of this contract will be considered only if presented in writing within one week of their date of delivery. Unless claims have been submitted, fully recondition or replace damaged items.
- F. Maintenance of equipment and systems: Maintain equipment and systems until Final Acceptance. Ensure adequate protection of equipment and material during delivery, storage, installation and shutdown and during delays pending final test of systems and equipment because of seasonal conditions. Protect work and equipment from damage and exposure to moisture and outdoor extreme temperature conditions until finally inspected, tested, and accepted. Carefully store materials and equipment that is not immediately installed after delivery to site. Close open ends of work including piping and ductwork with temporary covers or plugs during construction to prevent entry of obstructing material or debris.
- G. Use of premises shall be restricted as follows

1. Remove and dispose of dirt and debris, and keep premises clean. During progress of work, remove unused material and equipment. Maintain building and premises in neat and clean condition, clean and wash required to maintain appearance and operation of equipment.
  2. Store materials in a manner that will maintain an orderly clean appearance. If stored on-site in open or unprotected areas, equipment and material shall be kept off the ground by means of pallets or racks, and covered with tarpaulins.
  3. Do not interfere with function of existing sewers and water and gas mains, electrical, or mechanical systems and services. Extreme care shall be observed to prevent debris from entering pipe, ductwork and equipment.
- H. Surveys and Measurements
1. Base measurements, both horizontal and vertical, on reference points established by Contractor and be responsible for correct lay out of work.
  2. In event of discrepancy between actual measurements and those indicated, notify Architect in writing and do not proceed with work until written instructions have been issued.
- I. Fireproofing
1. Clips, hangers, clamps, supports and other attachments to surfaces to be fireproofed shall be installed, insofar as possible, prior to start of spray fiber work.
  2. Ducts, piping and other items that would interfere with proper application of fireproofing shall be installed after completion of spray fiber work.
  3. Patching and repairing of fireproofing due to cutting or damaging to fireproofing during course of work specified under this Section shall be performed by installer of fireproofing and paid for by trade responsible for damage and shall not constitute grounds for an extra to Owner.
- J. Temporary Utilities
1. Refer to Division 01 for project requirements.
  2. Coordinate work under this Section with progress of construction so that permanent heating system will be ready to provide temporary heating if permitted by Owner and Architect as soon as building is closed in.
  3. Provide and direct labor required for attendance, operation and final restoration of permanent heating system if used for temporary heating purposes. Continuous direct attendance shall be provided whenever permanent system is in operation prior to acceptance of permanent heating system by Owner.
- K. Air Bound Systems
1. If, after systems are operational, piping systems, coils or other apparatus are stratified or air bound (by vacuum or pressure), they shall be re-piped with new fittings, air vents, or vacuum breakers at no extra cost. If connections are concealed in furring, floors, or ceilings, installing trade shall bear all expenses of tearing up and refinishing construction and finish, leaving same in as good condition as before it was disturbed.
- L. Site Logistics
1. Unload materials and equipment delivered to site. Pay costs for rigging, hoisting, lowering and moving equipment on and around site, in building or on roof.

### **3.3 CONTINUITY OF SERVICES**

- A. Do not interrupt existing services without Owner's approval.
- B. Schedule interruptions in advance, according to Owner's instructions. Submit, in writing, with request for interruption, methods proposed to minimize length of interruption.
- C. Interruptions shall be scheduled at times of day and work so that they have minimal impact on Owner's operations.

- D. Coordinate shutdowns of existing systems as follows:
  - 1. Give proper notice to Owner when making shutdowns; a minimum of fourteen full days are required.
  - 2. Minimize shutdowns.
  - 3. Provide temporary services where required and perform shutdowns and tie-ins at a time convenient to Owner.
  - 4. Complete and file the Owner's shutdown notice questionnaire.
  - 5. Perform required survey and inspection work required by the notice for shutdown.
- E. Include premium time work associated with interruptions of services and/or shutdowns to avoid disruption to Owner's operations.

### **3.4 CLEANING**

- A. Cleaning shall be performed prior to commissioning. Refer to individual Division 23 Sections for additional requirements.
- B. Ductwork
  - 1. Ducts shall be thoroughly cleaned so that no dirt or dust shall be discharged from diffusers, registers or grilles, when system is operated.
  - 2. Provide temporary connections required for cleaning. Provide cheesecloth for openings during cleaning.
  - 3. Replace filters prior to final inspection and testing.
- C. Piping
  - 1. Furnish pipe cleaning chemicals, chemical feed equipment, materials and labor necessary to clean piping.
  - 2. Permanently install necessary chemical injection fittings complete with stop valves.
  - 3. After piping systems have been pressure tested and approved for tightness, clean and flush piping as specified and in accordance with applicable codes.
  - 4. Maintain continuous blowdown and make-up during flushing operation.
- D. Equipment
  - 1. After completion of project, clean the exterior surface of equipment, including concrete residue, dirt and paint residue.

### **3.5 MEP AND FIRE PROTECTION COMPLETION REQUIREMENTS**

- A. Project Punch List Procedure and Representations to Authorities
  - 1. When the contract work is substantially complete, if requested by the Contractor, the Engineer will do an inspection of the relevant work to confirm completion status. Prior to the inspection, the Contractor shall submit a punch list of remaining items to be completed as well as the Testing, Adjustment, and Balance report. In the course of the inspection the Engineer will add to the Contractor's punch list any observed remaining work that is not already on it, and provide the modified punch list, in a medium selected at the Engineer's discretion, for the Contractor's convenience in closing out the work.
  - 2. Regardless of what the Engineer observes and does not observe in the inspection, the responsibility for successful completion of the contract in all of its details remains with the Contractor.
  - 3. If, when the Engineer arrives at the site certain areas are not complete and ready for inspection at the substantial completion stage, the Engineer will not review these areas.
  - 4. Confirmation of Punch List Remediation. Once the engineer has submitted the punch list so modified, it shall be the responsibility of the Contractor to confirm that all the listed items have been correctly remedied. Upon receipt of such confirmation, and at the request of the Contractor, the engineer will re-inspect the site to confirm completion.

5. Contractor shall provide certifications to authorities such as Building Departments if so required. Also, if authorities require from the Engineer certifications, affidavits, or other type of representations, the Contractor shall provide to the Engineer a certified punch list of remaining work for final completion of the project, suitable for the Engineer to attach to the requested representations.

B. Occupancy Permit

1. Contractor shall prepare and submit the below life-safety related items as a prerequisite for construction completion and occupancy. These shall be submitted to the Engineer prior to filing for the occupancy permit so that the Engineer can provide the completion affidavit to the AHJ in a timely fashion. Provide a copy of all documents to Architect and to Owner. The required Contractor submittals include:
  - a. Contractor's certification that MEP systems have been installed in compliance with the Permit Documents
  - b. Contractor's statement of compliance of (a) the fire protection and fire alarm installation with the contract documents, and (b) testing of the fire alarm in accordance with the manufacturer's specifications.
  - c. Contractor's certification that acceptance tests of the fire protection and life safety systems have been successfully completed.
  - d. Contractor's Test and Material Certificates (per NFPA) for fire protection, fire alarm, smoke control and emergency power.
  - e. As-builts of the fire protection system.
  - f. As-builts of MEP systems (including those aspects of the fire protection system operated by the building controls such as smoke dampers and fan shut down).
  - g. Special Inspector Reports (smoke control system testing).
  - h. VAC Air and Water Balancing Reports.
  - i. Submit preliminary mechanical commissioning report (covering functional testing of HVAC systems and controls and domestic water) to owner and obtain letter from owner acknowledging receipt of same.
  - j. Report covering preliminary commissioning of emergency and standby power.
  - k. Report covering preliminary commissioning of lighting controls.
  - l. Certification of successful emergency egress lighting test.
  - m. Domestic water systems testing, chlorination and water quality documentation.
  - n. Certification of completion of code-related items on contractor's punch list and supplemental architectural and engineering punch lists.
  - o. List of remaining punch list items for 100 percent MEP completion.

C. Startup, Pre-Commissioning, and Commissioning

1. Completion of startup, pre-commissioning, and commissioning shall be accomplished as a prerequisite for substantial completion.
2. Below are minimum requirements for startup and pre-commissioning. Additional requirements may be found in other specifications Sections such as "Commissioning" or "Testing, Adjustment and Balancing."
3. Testing and balancing of HVAC shall occur after startup and pre-commissioning.
4. Operate and maintain systems and equipment until final acceptance by the Owner.
5. All warranties shall not begin until final acceptance of the systems and equipment by the Owner, which does not occur until systems have completed commissioning.
6. The Owner maintains the right to have access to the entire project site to develop his own operational procedures.
7. For each of the mechanical and electrical trades, prepare a room by room Startup and Pre-Commissioning Form which lists equipment with moving parts or with combustion or electric heating processes. Lighting controls shall be included in the list. Include equipment name, make and model number, date of Visual Inspection and names and signatures of attendees, date of Startup and names and signatures of attendees, date that the item has been placed into system-wide automatic operation.
8. Visual Inspection shall be attended by a qualified representative of the manufacturer. Confirm that equipment is installed, mounted and supported per manufacturer's recommendations. Confirm proper direction of rotation.

9. Startup. Conform to startup and testing procedures outlined in the relevant specification Sections. Startup shall be attended by a qualified representative of the manufacturer. Start each piece of equipment and check its operation in accordance with manufacturer's recommendations. Confirm that equipment operates and cycles appropriately under automatic control. Confirm satisfactory operation in all operating modes (e.g. normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
10. Leaks, damage and defects discovered or resulting from startup and pre-commissioning shall be repaired or replaced to like-new condition with acceptable materials. Tests shall be continued until system operates without adjustments or repairs.
11. When all equipment in a system has been started, place entire system in operation under automatic control and confirm system-wide operation.
12. Submit completed Startup Forms as an Information Submittal.

D. Demonstration of Successful Operation

1. After components and systems have been commissioned (or, if there is no commissioning, after startup), provide a 2 week, 24 hour per day fully functional automatic operation period of systems simultaneously. This shall be successfully concluded before systems are accepted by Owner.

E. Project Close-Out Procedure

1. General
  - a. The requirements of this Section are in addition to and supplement the requirements outlined in Division 01.
2. Project Close-Out Checklist
  - a. Review requirements of each Section of the specifications and submit for approval to Architect the sign-off forms that shall become the project close-out checklist. Do not group items; provide a separate line item for each required item. The checklist, at a minimum, shall include the information shown below in the Project Close-Out Checklist Example. The Architect and/or Owner may incorporate additional specific items to the following checklist which shall become part of the project requirements.
  - b. Project Close-Out Checklist Example:

PROJECT CLOSE-OUT			
PROJECT:			
DIVISION NO.:			
CONTRACTOR:			
ITEM <sup>1</sup>	DATES		OWNER'S SIGN-OFF
	COMPLETED	RECEIVED BY OWNER	
Permits			
City and County Inspection			
Manufacturer's Warranties			
Contractor's Warranties			
State Fire Rating Data			
Copy of Final Shop Drawings			
List and Possession of Spare Parts			
Pressure Tests			
Equipment Tests Required by Specs			
Startup and Pre-Commissioning Forms			

<sup>1</sup> Provide separate line item for each specified item (do not group items)



Testing Adjustment and Balancing Report			
Manufacturer/Vendor Training of Owner's Personnel Required by Specs			
O & M Manuals			
Record Documents			
Coordination Drawings			
Sanitization Reports			
Commissioning Reports/Letters/Forms			
On Site Training Complete			
Protective Device Settings			
Valve Tags and Charts			
Final ATC Installation Drawings			
Insurance Underwriters Approvals			
Final Punch List (Initialed by contractor that items are complete)			
Building Certificate of Occupancy (CO)			
24 Hour Phone No. for Service During Guarantee Period			
Smoke Control Special Inspection Report			

**END OF SECTION**

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## **SECTION 21 05 00 - COMMON WORK RESULTS FOR FIRE SUPPRESSION**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Mechanical sleeve seals.
  - 3. Sleeves.
  - 4. Escutcheons.
  - 5. Grout.
  - 6. Fire-suppression equipment and piping demolition.
  - 7. Equipment installation requirements common to equipment sections.
  - 8. Painting and finishing.
  - 9. Concrete bases.
  - 10. Supports and anchorages.

#### **1.3 DEFINITIONS**

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
  - 1. CPVC: Chlorinated polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
  - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
  - 2. NBR: Acrylonitrile-butadiene rubber.

#### **1.4 SUBMITTALS**

- A. Product Data: For the following:
  - 1. Mechanical sleeve seals.
  - 2. Escutcheons.
- B. Welding certificates.

#### **1.5 QUALITY ASSURANCE**

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- C. Pipe and fittings shall be protected from moisture. Pipe and fittings shall not be stored directly on ground. Pipe and fittings exposed to moisture and showing significant rust shall be removed from site, and shall not be installed.

#### **1.7 COORDINATION**

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. In other Part 2 articles where subparagraph 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, the manufacturers specified.

### **2.2 PIPE, TUBE, AND FITTINGS**

- A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### **2.3 JOINING MATERIALS**

- A. Refer to individual Division 21 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - 2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining CPVC Plastic Piping: ASTM F 493.

### **2.4 MECHANICAL SLEEVE SEALS**

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 1. Manufacturers:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.

- d. Pipeline Seal and Insulator, Inc.
2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Plastic. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## **2.5 SLEEVES**

- A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  1. Underdeck Clamp: Clamping ring with set screws.

## **2.6 GROUT**

- A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
  1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
  3. Packaging: Premixed and factory packaged.

## **PART 3 - EXECUTION**

### **3.1 FIRE-SUPPRESSION DEMOLITION**

- A. Refer to Division 01 and Division 02 for general demolition requirements and procedures.
- B. Disconnect, demolish, and remove fire-suppression systems, equipment, and components indicated to be removed.
  1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
  2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
  3. Equipment to Be Removed: Disconnect and cap services and remove equipment.
  4. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  5. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
- C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

### 3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. At the end of day all pipe opening shall be covered or capped to minimize the likelihood of introduction of foreign materials into piping. All piping not covered or which has had covering damaged shall be visually inspected internally to confirm no obstructions have been introduced to the piping.
- M. Sleeves are not required for core-drilled holes located in stairwells.
- N. Permanent sleeves are not required for holes formed by removable PE sleeves.
- O. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - 2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
  - 3. Install sleeves that are large enough to provide adequate clearance in accordance with NFPA 13 requirements. Use the following sleeve materials:
    - a. Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
    - b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
    - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 for flashing.
      - 1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 for materials and installation.
- P. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals. Sleeve to provide adequate clearance in accordance with NFPA 13 requirements.
1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
  2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
  3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Q. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 for materials.
- S. Verify final equipment locations for roughing-in.
- T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### **3.3 PIPING JOINT CONSTRUCTION**

- A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

### **3.4 PAINTING**

- A. Painting of fire-suppression systems, equipment, and components is specified in Division 09.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

### **3.5 CONCRETE BASES**

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
  2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
  3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
  7. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 03.

### **3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGES**

- A. Refer to Division 05 for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

### **3.7 ERECTION OF WOOD SUPPORTS AND ANCHORAGES**

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor fire-suppression materials and equipment.



- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

### **3.8 GROUTING**

- A. Mix and install grout for fire-suppression equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

**END OF SECTION**

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## **SECTION 21 05 53 - IDENTIFICATION FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Stencils.
  - 5. Valve tags.
  - 6. Warning tags.
  - 7. Hydraulic design information sign.
  - 8. General information sign.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment-Label Schedule: Include a listing of all equipment to be labeled and the proposed content for each label.
- D. Valve Schedules: Valve numbering scheme.
- E. Information Sign Proofs: Submit proposed completed information signs with all required data, as well as proposed installation details.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For each piping system to include in maintenance manuals.

## **PART 2 - PRODUCTS**

### **2.1 EQUIPMENT LABELS**

- A. Provide custom labels for all equipment, in addition to manufacturer's provided nameplates.
- B. Metal Labels for Equipment:
  - 1. Material and Thickness: Brass, 0.032 inch (0.8 mm) thick, with predrilled holes for attachment hardware.
  - 2. Letter Color: White.
  - 3. Background Color: Red.
  - 4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
  - 5. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  - 6. Fasteners: Stainless-steel rivets.
  - 7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Plastic Labels for Equipment:
  - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, with predrilled holes for attachment hardware.
  - 2. Letter Color: White.
  - 3. Background Color: Red.
  - 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
  - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
  - 6. Minimum Letter Size: 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  - 7. Fasteners: Stainless-steel rivets.
  - 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- D. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- E. Equipment-Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

### **2.2 WARNING SIGNS AND LABELS**

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, with predrilled holes for attachment hardware.
- B. Letter Color: White.
- C. Background Color: Red.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- G. Fasteners: Stainless-steel rivets.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information, plus emergency notification instructions.

### **2.3 PIPE LABELS**

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Pipe-Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; pipe size; and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches high.
- D. Pipe-Label Colors:
  - 1. Background Color: Red.
  - 2. Letter Color: White.

### **2.4 VALVE TAGS**

- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping-system abbreviation and 1/2-inch (13-mm) numbers.
  - 1. Tag Material: Brass, 0.032 inch (0.8 mm) thick, with predrilled holes for attachment hardware.
  - 2. Fasteners: Brass wire-link chain, beaded chain, or S-hook.
  - 3. Valve-Tag Color: Red.
  - 4. Letter Color: White.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1. Valve-tag schedule shall be included in operation and maintenance data.

### **2.5 WARNING TAGS**

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
  - 1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum <Insert size>.
  - 2. Fasteners: Brass grommet and wire.
  - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

## **2.6 HYDRAULIC DESIGN INFORMATION SIGN**

- A. Material and Thickness: Multi-layer, multi-color plastic, mechanically engraved, 1/8 inch (32 mm) thick.
- B. Letter Color: White
- C. Background Color: Red
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Letter Size: 1/4 inch (6.4 mm).
- F. Adhesive: Contact type permanent adhesive, compatible with label and with substrate.
- G. Sign shall contain the following information at minimum:
  1. Location of design area
  2. Discharge density over the design area
  3. Required flow and residual pressure at the fire pump discharge, or if no pump is present at the connection to the water supply.
  4. Occupancy classification, or commodity classification, maximum storage height, and configuration.
  5. Hose stream allowance.
  6. Installing Contractor's name and contact information.

## **2.7 GENERAL INFORMATION SIGN**

- A. Material and Thickness: Multi-layer, multi-color plastic, mechanically engraved, 1/8 inch (32 mm) thick.
- B. Letter Color: White
- C. Background Color: Red
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- E. Minimum Letter Size: 1/4 inch (6.4 mm).
- F. Adhesive: Contact type permanent adhesive, compatible with label and with substrate.
- G. Sign shall contain the following information at minimum:
  1. Name and location of facility protected
  2. Occupancy classification
  3. Commodity classification
  4. Presence of high-piled and/or rack storage
  5. Maximum height of storage planned
  6. Aisle width planned
  7. Encapsulation of pallet loads
  8. Presence of solid shelving
  9. Flow test data
  10. Presence of flammable/combustible liquids
  11. Pressure of hazardous materials
  12. Presence of other special storage
  13. Location of auxiliary drains and low point drains on dry pipe and preaction systems

14. Original results of main drain flow test and date conducted
15. Name of installing contractor and contact information

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

#### **3.2 LABEL INSTALLATION**

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install or permanently fasten labels on each major item of mechanical equipment.
- D. Locate equipment labels where accessible and visible.
- E. Pipe-Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  1. Near each valve and control device.
  2. Near each branch connection excluding short takeoffs. Where flow pattern is not obvious, mark each pipe at branch.
  3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  4. At access doors, manholes, and similar access points that permit view of concealed piping.
  5. Near major equipment items and other points of origination and termination.
  6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
  7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

#### **3.3 VALVE-TAG INSTALLATION**

- A. Install tags on valves and control devices in piping systems. List tagged valves in a valve-tag schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and with captions similar to those indicated in "Valve-Tag Size and Shape" Subparagraph below:
  1. Valve-Tag Size and Shape:
    - a. Fire-Suppression Standpipe: 2 inches (50 mm), round.
    - b. Wet-Pipe Sprinkler System: 2 inches (50 mm), round.
    - c. Dry-Pipe Sprinkler System: 2 inches (50 mm), round.
    - d. Foam-Water System: 2 inches (50 mm), round.
    - e. Clean-Agent Fire-Extinguishing System: 2 inches (50 mm), round.

#### **3.4 WARNING-TAG INSTALLATION**

- A. Write required message on, and attach warning tags to, equipment and other items where required.

### **3.5 INFORMATION SIGN INSTALLATION**

- A. Provide separate hydraulic design information sign for each system design criteria.
- B. Hydraulic design information signs shall be permanently mounted at fire service entrance.
- C. General information sign shall be permanently mounted at fire service entrance. Provide second general information sign at location approved by the Fire Department.

**END OF SECTION**

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## **SECTION 21 13 13 - WET-PIPE SPRINKLER SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Pipes, fittings, and specialties.
  - 2. Fire-protection valves.
  - 3. Fire-department connections.
  - 4. Sprinklers.
  - 5. Excess-pressure pumps.
  - 6. Alarm devices.
  - 7. Manual control stations.
  - 8. Pressure gages.

#### **1.3 DEFINITIONS**

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.

#### **1.4 SYSTEM DESCRIPTIONS**

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

#### **1.5 PERFORMANCE REQUIREMENTS**

- A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
- B. Contractor shall develop detailed layout and provide, install, and test complete combination sprinkler/standpipe system as indicated on plans and specifications.
- C. Drawings are diagrammatic. They are not intended to be absolutely precise; they are not intended to specify or to show every offset, fitting and component. The purpose of the drawings is to indicate a system concept, the main components of the system and the approximate geometrical rela-



tionships, provide all other components and materials necessary to make the systems fully complete and operational.

- D. NFPA Standards: Sprinkler/standpipe system layout, equipment, specialties, accessories, installation and testing shall comply with the following:
  - 1. NFPA 13 - Installation of Sprinkler Systems.
  - 2. NFPA 14 - Installation of Standpipes and Hose Systems.
  - 3. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances
- E. FM Global: Sprinkler/standpipe system layout, equipment, specialties, accessories, installation and testing shall comply with the following FM Global datasheets:
  - 1. Datasheet 2-0 - Installation Guidelines for Automatic Sprinklers
  - 2. Datasheet 3-26 - Fire Protection Water Demand for Non-Storage Sprinklered Properties
  - 3. Datasheet 3-11 - Pressure Reducing Valves for Fire Protection Service
- F. All system components shall be UL listed and FM approved as required by referenced standards above.
- G. Where conflicts between referenced standards, codes, drawings, and specifications exist the most stringent shall apply unless approved in writing by the Engineer.
- H. Sprinkler protection shall be provided in all spaces including but not limited to:
  - 1. Electric room and closets
  - 2. Tel/data closets
  - 3. Entry vestibules
  - 4. Dwelling unit closets
  - 5. Dwelling unit bathrooms
  - 6. Hydraulic elevator pits
- I. Location of all visible system components shall be approved by the Architect. Provide additional sprinklers above code required minimums as required by the Architect.
- J. Sprinkler system design shall be approved by authorities having jurisdiction.
- K. Margin of Safety for Available Water Flow and Pressure: 10 psi( ), including losses through water-service piping, valves, and backflow preventers.
- L. Refer to drawings for sprinkler system design criteria.
- M. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

## 1.6 SUBMITTALS

- A. All submittals shall be in accordance with Division 20, Common Mechanical and Electrical Requirements.
- B. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- C. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work. Plans shall include all information required of working plans in NFPA 13.
- D. Reflected Ceiling Plan: Submit separate reflected ceiling plans indicating all sprinkler and exposed piping. Plan should not show concealed system components.

- E. Hydraulic Calculations prepared in accordance with the requirements of NFPA 13 shall accompany the Working Plans. A separate calculation for each system shall be submitted as indicated by the drawings.
- F. Seismic Bracing Calculations prepared in accordance with NFPA 13 Figure A.9.3.5(a) shall accompany the working plans.
- G. Coordination Drawings: Prepare a single set of coordination drawings with all mechanical and electrical trades, in accordance with Division 20, Common Mechanical and Electrical Requirements.
- H. Qualification Data: For qualified Installer and system technician.
- I. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- J. Welding certificates.
- K. Fire-hydrant flow test report.
- L. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- M. Field quality-control reports.
- N. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

## **1.7 QUALITY ASSURANCE**

- A. Qualifications of Installer
  1. Installing Contractor shall have successfully installed multiple automatic sprinkler/standpipe systems of similar type and size, for buildings of similar construction and occupancy.
  2. For CPVC piping installation, all installers shall have been trained by piping manufacturer within the last two years.
- B. Qualifications of System Technician
  1. Shop drawings, fabrication plans, system calculations and as-built drawings shall be prepared by or under the direct supervision of a technician with a minimum Level III Certification in Automatic Sprinkler System Layout by the National Institute for Certification in Engineering Technologies (NICET), or a Professional Engineer.
- C. Record Drawings
  1. As work progresses and for the duration of the Contract, maintain complete and separate set of prints of Working Plans at job site at all times. Record work completed and all deviations from reviewed fabrication plans clearly and accurately. Include actual locations of existing utilities if they differ from design documents. Valve tags shall be recorded on working plans as installed.
- D. Welding Procedure
  1. Welding procedure(s) to be used and performance of all welders and welding operators shall meet or exceed the requirements of AWS B2.1 Specification for Welding Procedure and Performance Qualification.
  2. Contractor shall have a written quality control program, mark all welds and maintain certified records for all welding in accordance with NFPA 13 requirements.

- E. Project Punchlist Procedure
  - 1. When the contract work is substantially complete, the Contractor shall physically walk down the installation and prepare a punchlist containing an itemization of work remaining for 100 percent completion. The punchlist shall be submitted to the Architect prior to request for final project visit.
- F. 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.
- G. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
  - 1. NFPA 13, "Installation of Sprinkler Systems."
  - 2. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

## **1.8 COORDINATION**

- A. Contractor shall coordinate with other trades in accordance with Division 20, Common Mechanical and Electrical Requirements.

## **1.9 EXTRA MATERIALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.
  - 2. Custom Sprinklers: Provide a minimum of six spare coverplates or sprinklers for each custom finish in addition to spares required by NFPA 13.

## **PART 2 - PRODUCTS**

### **2.1 PIPING MATERIALS**

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

### **2.2 STEEL PIPE AND FITTINGS**

- A. Standard Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M, A795 or A135. Pipe ends may be factory or field formed to match joining method.
- B. Schedule 10, Galvanized- and Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.
- C. Galvanized- and Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.
- D. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.

- E. Galvanized and Uncoated, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
- F. Malleable- or Ductile-Iron Unions: UL 860.
- G. Cast-Iron Flanges: ASME 16.1, Class 125.
- H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.
- I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.
- J. Grooved-Joint, Steel-Pipe Appurtenances:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International, Inc.
    - b. Tyco Fire & Building Products LP.
    - c. Victaulic Company.
  - 2. Pressure Rating: 175 psig (1200 kPa) minimum.
  - 3. Galvanized and Painted, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
  - 4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

### 2.3 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L (**ASTM B 88M, Type B**) and ASTM B 88, Type M (ASTM B 88M, Type C) water tube, drawn temper.
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

### 2.4 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free.
  - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
  - 2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- D. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

## 2.5 PIPE HANGERS AND FASTENERS

- A. General Requirements
  - 1. Structural attachments and pipe hangers shall be UL listed and FM approved.
  - 2. Powder driven or pre-expanded inserts shall not be used.
  - 3. Threaded connections shall not be used for attachments to concrete.
- B. Drop in Anchors
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hilti Corp.
    - b. ITW Red Head
    - c. Powers Fasteners, Inc.
  - 2. Standard: UL 203.
  - 3. Material: Mild steel with zinc plating.
- C. Concrete Inserts (Cast-In)
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Tolco
    - b. Hilti Corp.
    - c. Powers Fasteners, Inc.
  - 2. Material: Carbon steel, galvanized
- D. Hanger Rod
  - 1. Material: Carbon steel, galvanized
- E. Pipe Hangers, piping 3 inches and smaller
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Tolco
    - b. Cooper B-Line
    - c. Anvil International
  - 2. Material: Steel, galvanized
  - 3. Type: Adjustable band type, or clevis
  - 4. Band type hangers used on CPVC piping shall have flared or beveled edges
- F. Pipe Hangers, piping 4 inches and larger
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Tolco
    - b. Cooper B-Line
    - c. Anvil International
  - 2. Material: Steel, galvanized
  - 3. Type: Clevis; band hangers shall not be used on piping 4 inches and larger
- G. Attachments to Steel
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Tolco
    - b. Cooper B-Line
    - c. Anvil International
  - 2. Material: Carbon or malleable steel, galvanized
  - 3. Type: Beam clamp
  - 4. Beam clamps shall be installed with retaining straps

## 2.6 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
1. Valves shall be UL listed or FM approved.
  2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).
  3. Control valves on suction side of fire pump and at backflow preventer shall be OS&Y Gate Valves.
  4. All control valves shall be provided with tamper switches.
- B. Ball Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Victaulic Company.
  2. Standard: UL 1091 except with ball instead of disc.
  3. Pressure Rating: 300 psi
  4. Valves NPS 2 (DN 50) and Smaller: Bronze body with threaded ends.
  5. Valves NPS 2-1/2 (DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
  6. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.
  7. Valves shall be provided with integral tamper switch and visual position indicator.
- C. Bronze Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Milwaukee Valve Company.
  2. Standard: UL 1091.
  3. Pressure Rating: 175 psig (1200 kPa).
  4. Body Material: Bronze.
  5. End Connections: Threaded.
- D. Iron Butterfly Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International, Inc.
    - b. Tyco Fire & Building Products LP.
    - c. Victaulic Company.
  2. Standard: UL 1091.
  3. Pressure Rating: 300 psig (2070 kPa).
  4. Body Material: Ductile iron.
  5. Disk: Ductile iron.
  6. End Connections: Grooved.
  7. Valve shall have integral tamper switch and visual position indicator.
- E. Check Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International, Inc.
    - b. Tyco Fire & Building Products LP.
    - c. Victaulic Company.
    - d. Viking Corporation.
  2. Standard: UL 312.
  3. Pressure Rating: 300 psig (2070 kPa).
  4. Type: Swing check.
  5. Body Material: Ductile iron.
  6. End Connections: Flanged or grooved.

## 2.7 TRIM AND DRAIN VALVES

- A. General Requirements:
  - 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
  - 2. Pressure Rating: 175 psig (1200 kPa) minimum.
- B. Angle Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Fire Protection Products, Inc.
    - b. United Brass Works, Inc.
- C. Ball Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International, Inc.
    - b. Conbraco Industries, Inc.; Apollo Valves.
    - c. Fire-End & Croker Corporation.
    - d. Kennedy Valve; a division of McWane, Inc.
    - e. Milwaukee Valve Company.
    - f. NIBCO INC.
    - g. Potter Roemer.
    - h. Tyco Fire & Building Products LP.
    - i. Victaulic Company.
    - j. Watts Water Technologies, Inc.
- D. Globe Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Fire Protection Products, Inc.
    - b. United Brass Works, Inc.

## 2.8 SPECIALTY VALVES

- A. General Requirements:
  - 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
  - 2. Pressure Rating:
    - a. Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.
  - 3. Body Material: Cast or ductile iron.
  - 4. Size: Same as connected piping.
  - 5. End Connections: Flanged or grooved.
- B. Alarm Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Reliable Automatic Sprinkler Co., Inc.
    - b. Tyco Fire & Building Products LP.
    - c. Victaulic Company.
    - d. Viking Corporation.
  - 2. Standard: UL 193.
  - 3. Design: For horizontal or vertical installation.
  - 4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.
  - 5. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
  - 6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

- C. Automatic (Ball Drip) Drain Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following] :
    - a. AFAC Inc.
    - b. Reliable Automatic Sprinkler Co., Inc.
    - c. Tyco Fire & Building Products LP.
  - 2. Standard: UL 1726.
  - 3. Pressure Rating: 175 psig (1200 kPa) minimum.
  - 4. Type: Automatic draining, ball check.
  - 5. Size: NPS 3/4 (DN 20).
  - 6. End Connections: Threaded.

## 2.9 SPRINKLER SPECIALTY PIPE FITTINGS

- A. Branch Outlet Fittings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International, Inc.
    - b. National Fittings, Inc.
    - c. Tyco Fire & Building Products LP.
    - d. Victaulic Company.
  - 2. Standard: UL 213.
  - 3. Pressure Rating: 175 psig (1200 kPa) minimum.
  - 4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
  - 5. Type: Mechanical-T and -cross fittings.
  - 6. Configurations: Full ductile-iron housing with branch outlets. Snap on and strapless type shall not be used.
  - 7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
  - 8. Branch Outlets: Grooved, plain-end pipe, or threaded.
- B. Flow Detection and Test Assemblies:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. AGF Manufacturing Inc.
    - b. Reliable Automatic Sprinkler Co., Inc.
    - c. Tyco Fire & Building Products LP.
    - d. Victaulic Company.
  - 2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
  - 3. Pressure Rating: 175 psig (1200 kPa) minimum.
  - 4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
  - 5. Size: Same as connected piping.
  - 6. Inlet and Outlet: Threaded.
- C. Branch Line Testers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Elkhart Brass Mfg. Company, Inc.
    - b. Fire-End & Croker Corporation.
    - c. Potter Roemer.
  - 2. Standard: UL 199.
  - 3. Pressure Rating: 175 psig (1200 kPa).
  - 4. Body Material: Brass.
  - 5. Size: Same as connected piping.
  - 6. Inlet: Threaded.
  - 7. Drain Outlet: Threaded and capped.



8. Branch Outlet: Threaded, for sprinkler.
- D. Sprinkler Inspector's Test Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. AGF Manufacturing Inc.
    - b. Tyco Fire & Building Products LP.
    - c. Victaulic Company.
    - d. Viking Corporation.
  2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
  3. Pressure Rating: 175 psig (1200 kPa) minimum.
  4. Body Material: Cast- or ductile-iron housing with sight glass.
  5. Size: Same as connected piping.
  6. Inlet and Outlet: Threaded.
- E. Adjustable Drop Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CECA, LLC.
    - b. Corcoran Piping System Co.
    - c. Merit Manufacturing; a division of Anvil International, Inc.
  2. Standard: UL 1474.
  3. Pressure Rating: 250 psig (1725 kPa) minimum.
  4. Body Material: Steel pipe with EPDM-rubber O-ring seals.
  5. Size: Same as connected piping.
  6. Length: Adjustable.
  7. Inlet and Outlet: Threaded.
- F. Flexible, Sprinkler Hose Fittings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Tyco Fire and Building Products LP.
    - b. FlexHead Industries, Inc.
    - c. Viking Corporation.
    - d. Victaulic Company,
  2. Standard: UL 1474.
  3. Type: Flexible hose for connection to sprinkler, with bracket for connection to ceiling grid. Connection shall be minimum 1 inch internal diameter corrugated stainless steel tubing with braided stainless steel jacket. Assembly shall be UL-listed and FM approved.
  4. Pressure Rating: 175 psig (1200 kPa) minimum.
  5. Size: Same as connected piping, for sprinkler.

## 2.10 SPRINKLERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Reliable Automatic Sprinkler Co., Inc.
  2. Tyco Fire & Building Products LP.
  3. Victaulic Company.
  4. Viking Corporation.
- B. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
  2. Pressure Rating for Residential Sprinklers: 175 psig (1200 kPa) maximum.
  3. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.

- C. Automatic Sprinklers with Heat-Responsive Element:
  1. Early-Suppression, Fast-Response Applications: UL 1767.
  2. Nonresidential Applications: UL 199.
  3. Residential Applications: UL 1626.
- D. Unless otherwise noted, all sprinklers shall be of one manufacturer.
- E. Type.
  1. Standard spray sprinkler shall be used throughout (except as noted below).
  2. Residential type sprinklers shall be used within dwelling units in accordance with listing and NFPA 13 requirements.

SP-1 (All locations with finished ceilings)  Note: Provide [ ] custom finishes as required by Architect.	Sprinkler Type: Concealed (flat coverplate) Finish: White, Custom Response Application: UL listed Quick Response, FM Listed Standard Response Link Type: Solder K-Factor: 5.6 Thread: 1/2 NPT Model: Viking SIN VK404
SP-2 (All locations with exposed structure) Except Storage Areas	Sprinkler Type: Upright/Pendant Finish: Standard Brass Response Application: Quick Response Link Type: Glass Bulb K-Factor: 5.6 Thread: 1/2 NPT Model: Viking SIN VK300 (Upright) SIN VK302 (Pendant)
SP-9 (High Piled Storage Area)	Sprinkler Type: Upright Finish: Brass Response Application: Quick Response Link Type: Glass Bulb K-Factor: 11.2 Thread: 3/4 NPT Model: Viking SIN VK531

- F. Temperature Ratings
  1. Unless otherwise noted sprinkler temperature ratings shall be in accordance with NFPA 13.
- G. Sprinkler Guards:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Reliable Automatic Sprinkler Co., Inc.
    - b. Tyco Fire & Building Products LP.
    - c. Victaulic Company.
    - d. Viking Corporation.
  2. Standard: UL 199.
  3. Type: Wire cage with fastening device for attaching to sprinkler.
  4. Guard shall be approved for use with sprinkler.

**2.11 ALARM DEVICES**

- A. Alarm-device types shall match piping and equipment connections.
- B. Electrically Operated Alarm Bell:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Fire-Lite Alarms, Inc.; a Honeywell company.
    - b. Notifier; a Honeywell company.
    - c. Potter Electric Signal Company.
  2. Standard: UL 464.
  3. Type: Vibrating, metal alarm bell.
  4. Size: 6-inch (150-mm) minimum-diameter.
  5. Finish: Red-enamel factory finish, suitable for outdoor use.
- C. Water-Flow Indicators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Potter Electric Signal Company.
    - b. System Sensor; a Honeywell company.
    - c. Viking Corporation.
    - d. Watts Industries (Canada) Inc.
  2. Standard: UL 346.
  3. Water-Flow Detector: Electrically supervised.
  4. Components: 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.
  5. Type: Paddle operated.
  6. Pressure Rating: 250 psig (1725 kPa).
  7. Design Installation: Horizontal or vertical.
- D. Pressure Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Potter Electric Signal Company.
    - b. System Sensor; a Honeywell company.
    - c. Tyco Fire & Building Products LP.
    - d. Viking Corporation.
  2. Standard: UL 346.
  3. Type: Electrically supervised water-flow switch with retard feature.
  4. Components: Single-pole, double-throw switch with normally closed contacts.
  5. Design Operation: Rising pressure signals water flow.
- E. Valve Supervisory Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Fire-Lite Alarms, Inc.; a Honeywell company.
    - b. Potter Electric Signal Company.
    - c. System Sensor; a Honeywell company.
  2. Standard: UL 346.
  3. Type: Electrically supervised.
  4. Components: Single-pole, double-throw switch with normally closed contacts.
  5. Design: Signals that controlled valve is in other than fully open position.

## 2.12 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AMETEK; U.S. Gauge Division.
  2. Ashcroft, Inc.
  3. Brecco Corporation.
  4. WIKA Instrument Corporation.

- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
- D. Pressure Gage Range: 0 to 300 psig (0 to 2070 kPa).
- E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.
- F. Air System Piping Gage: Include "AIR" or "AIR/WATER" label on dial face.

### **2.13 flexible joint assembly**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. EBAA Iron, Inc.
- B. Double ball and socket flexible joint.
- C. Body Material: Ductile drum with 15 mil epoxy coating and EPDM gaskets.

### **2.14 SLEEVES**

- A. Cast-Iron Wall Pipe Sleeves: Cast or fabricated of cast iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, standard weight, zinc coated, plain ends.
- D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  1. Underdeck Clamp: Clamping ring with set-screws.

### **2.15 SLEEVE SEALS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Advance Products & Systems, Inc.
  2. Calpico, Inc.
  3. Metraflex, Inc.
  4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  2. Pressure Plates: Plastic.
  3. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements.

## 2.16 GROUT

- A. Standard: ASTM C 1107, Grade B, posthardening and volume adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink, and recommended for interior and exterior applications.
- C. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

### 3.2 pipe sizing

- A. Flush service piping to a minimum velocity of 10 ft/sec (**3 m/s**) prior to connecting to sprinkler system.
- B. Standpipes and Feed mains
  1. Sprinkler/Standpipe feed mains and standpipes upstream of floor control valve assemblies shall be no smaller than as indicated on the drawings.
  2. As part of the work, confirm the pipe sizing shown on the drawings with hydraulic calculations using the Hazen-Williams correlation in accordance with NFPA 14.
  3. Calculations shall be in accordance with NFPA 14 using the design criteria shown on the drawings.
  4. Standpipe hydraulic calculations shall include a 10 psi pressure loss for standard 2 1/2" fire department angle valves.
  5. The calculations shall confirm that the design criteria can be met with a minimum 10 psi "safety factor".
- C. Sprinkler piping
  1. Sprinkler mains including the floor control valve assembly shall be no smaller than as indicated on the drawings.
  2. As part of the work, sprinkler branch piping shall be sized based upon hydraulic calculations using the Hazen-Williams correlation in accordance with NFPA 13.
  3. Pipe sizing shall be such that the system demand can be met with a minimum 10 psi "safety factor".
  4. Where sprinkler systems are fed by two risers, pipe sizing shall be based upon supply from the hydraulically most remote riser only.
  5. Provide additional hydraulic calculations as required when the hydraulically most remote area is not readily apparent (not the geometrically most remote).
  6. For gridded systems, a minimum of three calculation areas shall be provided clearly demonstrating that the hydraulically most demanding area is being used.
  7. Calculation areas indicated by the design criteria shown on the drawings shall not be reduced due to the use of quick response sprinklers.
  8. Hydraulic calculations shall include manufacturer specific pressure loss for seismic separation assemblies and flexible sprinkler connections.

D. General

1. Do not perform pipe sizing calculations prior to submitting water supply flow test results for review.
2. Do not perform pipe sizing calculations prior to submitting a manufacturer's characteristic pump curve for the fire pump.
3. A legible water supply graph sheet shall be included with each hydraulic calculation.
4. Elevations used in hydraulic calculations shall have the same datum as the fire protection riser diagram included in the drawings.
5. The actual churn pressure of the fire pump as indicated by the manufacturer's characteristic pump curve shall be used in the calculations.
6. For systems with pressures exceeding 175 psi, a calculation at no flow conditions shall be submitted to indicate where pressure regulating valves are required. Static pressure shall be indicated for each level on riser diagram.
7. Where direct acting pressure regulating valves are used, submittal of calculations shall include a copy of the manufacturer's pressure loss chart with the calculated flow through the valve and resulting pressure drop clearly indicated.

**3.3 EXAMINATION**

- A. Examine sleeved penetrations through concrete and structural penetrations through steel and verify that they are suitable for intended piping installation.
- B. Examine walls and partitions and verify that they are suitable for installation of piping, cabinets, inlet connections and similar products.
- C. Examine areas to contain standpipe hose outlets including stairwells and vestibules and verify that door swings or other obstructions will not interfere with the installation or future operation of hose valves.
- D. Report conflicts with proposed solutions. Proceed with installation after conflicts have been resolved.

**3.4 SERVICE-ENTRANCE PIPING**

- A. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers in Division 21 Section "Facility Fire-Suppression Water-Service Piping."
- B. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

**3.5 WATER-SUPPLY CONNECTIONS**

- A. Connect sprinkler piping to building's interior water-distribution piping. Comply with requirements for interior piping in Division 22 Section "Domestic Water Piping."
- B. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

**3.6 PIPING INSTALLATION**

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
  1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- 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 (DN 8) 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. Fill sprinkler system piping with water.
- O. Install electric heating cables and pipe insulation on sprinkler piping in areas subject to freezing. Comply with requirements for heating cables in Division 21 "Heat Tracing for Fire-Suppression Piping" and for piping insulation in Division 21 Section "Fire-Suppression Systems Insulation."
- P. Installation of grooved pipe couplings shall be in accordance with manufacturer's recommendations.
- Q. Coupling bolts shall be tightened in accordance with manufacturer's bolt torque requirements.
- R. Excess gasket lubricant shall be removed from coupling housing after bolts are tightened.
- S. Where the use of drilled mechanical outlets is required, the removed coupon shall be attached to the fitting.
- T. Adjust relief valve(s) such that no water is discharged under normal system working pressure.
- U. Building Expansion Joints - Provide for expansion at building expansion joints with assemblies listed for that purpose. Coordinate the maximum value of building deflection with the appropriate Structural Section of the work.

- V. Galvanized Piping - Do not use welded joints on galvanized piping.
- W. Beam Clamps - Install all beam clamps with retaining straps.
- X. Fire Stopping - Provide through penetration fire stops in accordance with local building code requirements at pipe penetrations through rated walls, floors and assemblies.

### 3.7 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  1. Apply appropriate tape or thread compound to external pipe threads.
  2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
  1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.
- I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.
- J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- K. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Braze Joints" Chapter.
- L. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.
- M. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.



### **3.8 VALVE AND SPECIALTIES INSTALLATION**

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- 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 check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
  - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
  - 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
- E. Install all valves in locations that are readily accessible. Install system control valves in areas that allow for safe fire department access during emergency conditions.
- F. Install indicating valves such that indicator is clearly visible from the floor level below.
- G. Adjust each field adjustable direct acting pressure regulating valve in accordance with the manufacturer's recommendations. Valves for use as standpipe outlets shall be adjusted in accordance with the minimum and maximum pressure requirements indicated in NFPA 14. Valves for use as sprinkler system regulating devices shall be adjusted in accordance with the maximum pressure requirements of NFPA 13 and the minimum pressure requirements indicated by hydraulic calculations.
- H. Adjust relief valves such that no water is discharged under normal system working conditions.

### **3.9 SPRINKLER INSTALLATION**

- A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels with no visible deviation.
- B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.
- C. Install sprinklers such that cover plate or escutcheon is flush against gypsum or acoustical tile as recommended by manufacturer. Correct sprinklers that are not flush by adjusting them in accordance with the manufacturer's instructions and/or re-installing affected portions of the wall or ceiling assembly if required.
- D. Install sprinklers in accordance with the requirements of NFPA 13 regarding obstructions to sprinkler discharge. All obstructions such as ductwork, piping, lighting, cable trays, floating ornamental ceilings, etc. shall be considered. Adjust sprinkler locations and/or add sprinklers as necessary if obstructions are installed after the installation of the sprinklers and cannot be relocated to accommodate the sprinklers.
- E. Provide and install guards on sprinklers susceptible to mechanical damage.
- F. Provide and install baffles to prevent cold soldering of intermediate level sprinklers.

### **3.10 use of flexible sprinkler connections**

- A. Installation shall be in accordance with manufacturers recommendations.
- B. System hydraulic calculations shall include manufacturer specific equipment length.
- C. Where right angle/elbow connections are used for sprinkler attachment to flexible connection, equivalent length for flexible connection shall include pressure drop through angle/elbow.
- D. Drawings shall clearly indicate locations of all flexible sprinkler connections, manufacturer, length, and outlet type.
- E. Drawing details shall clearly indicate maximum bend radius, maximum number of bends, as well as attachment methods to all ceiling types.
- F. Provide visual indicator of tampering with attachment of sprinkler connection to ceiling via a manufacturer supplied tamper evident label.
- G. Connection to branch shall be made a minimum 45 degrees from horizontal. Where connections off a side or bottom of branchline are required due to coordination, locations shall be clearly indicated on shop drawings and approved by Engineer.

### **3.11 ESCUTCHEON INSTALLATION**

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
  - 1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
  - 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
  - 3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
  - 4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with rough-brass finish.
  - 5. Bare Piping in Equipment Rooms: One piece, cast brass.
  - 6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.
- C. Escutcheons for Existing Piping:
  - 1. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
  - 2. Insulated Piping: Split plate, stamped steel with concealed hinge and spring clips.
  - 3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
  - 4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
  - 5. Bare Piping in Unfinished Service Spaces: Split casting, cast brass with rough-brass finish.
  - 6. Bare Piping in Equipment Rooms: Split casting, cast brass.
  - 7. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

### **3.12 SLEEVE INSTALLATION**

- A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.

- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in new partitions, slabs, and walls as they are built.
- F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
- I. Seal space outside of sleeves in concrete slabs and walls with grout.
- J. Install sleeves that are large enough to provide NFPA required clearances between sleeve and pipe or pipe insulation unless otherwise indicated.
- K. Install sleeve materials according to the following applications:
  - 1. Sleeves for Piping Passing through Concrete Floor Slabs: -Steel pipe.
  - 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe.
    - a. Extend sleeves 2 inches (50 mm) above finished floor level.
    - b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements for flashing in Division 07 Section "Sheet Metal Flashing and Trim."
  - 3. Sleeves for Piping Passing through Gypsum-Board Partitions:
    - a. Steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).
    - b. Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.
  - 4. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe.
  - 5. Sleeves for Piping Passing through Exterior Concrete Walls:
    - a. Steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).
    - b. Cast-iron wall-pipe sleeves for pipes NPS 6 (DN 150) and larger.
    - c. Install sleeves that are large enough to provide NFPA 13 required clearance between sleeve and pipe or pipe insulation when sleeve seals are used.
  - 6. Sleeves for Piping Passing through Interior Concrete Walls:
    - a. Steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).
    - b. Galvanized-steel-sheet sleeves for pipes NPS 6 (DN 150) and larger.
- L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestop materials and installations in Division 07 Section "Penetration Firestopping."

### **3.13 SLEEVE SEAL INSTALLATION**

- A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.
- B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### **3.14 IDENTIFICATION**

- A. Install labeling and pipe markers on equipment and piping according to requirements in Division 21, Section "Identification for Fire Suppression Piping and Equipment".
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

### **3.15 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
  - 4. Energize circuits to electrical equipment and devices.
  - 5. Coordinate with fire-alarm tests. Operate as required.
  - 6. Coordinate with fire-pump tests. Operate as required.
  - 7. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### **3.16 CLEANING**

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

### **3.17 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves.

### **3.18 PIPING SCHEDULE**

- A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
- B. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:
  - 1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
  - 2. Type L (Type B) Type M (Type C), hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 and larger (DN 65 and larger), shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
3. Schedule 10, black-steel pipe with roll-grooved ends; painted, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

**END OF SECTION**

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## **SECTION 22 05 00 - COMMON WORK RESULTS FOR PLUMBING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Section. These requirements are applicable to the work of this Division, and are hereby incorporated by reference.

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Transition fittings.
  - 3. Dielectric fittings.
  - 4. Mechanical sleeve seals.
  - 5. Sleeves.
  - 6. Escutcheons.
  - 7. Grout.
  - 8. Equipment installation requirements common to equipment sections.
  - 9. Painting and finishing.
  - 10. Concrete bases.
  - 11. Supports and anchorages.

#### **1.3 DEFINITIONS**

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

## **1.4 SUBMITTALS**

- A. Product Data: For the following:
  - 1. Transition fittings.
  - 2. Dielectric fittings.
  - 3. Mechanical sleeve seals.
  - 4. Escutcheons.
- B. Welding certificates.

## **1.5 QUALITY ASSURANCE**

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

## **1.7 COORDINATION**

- A. Contractor shall provide support to the commissioning agent.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- D. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

### **2.2 PIPE, TUBE, AND FITTINGS**

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### **2.3 JOINING MATERIALS**

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
  - 2. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
  - 3. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - 4. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

### **2.4 DIELECTRIC FITTINGS**

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.



- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
  - 1. Manufacturers:
  - 2. Eclipse, Inc.
  - 3. Epco Sales, Inc.
  - 4. Hart Industries, International, Inc.
  - 5. Watts Industries, Inc.; Water Products Div.
  - 6. Zurn Industries, Inc.; Wilkins Div.
  
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
  - 1. Manufacturers:
  - 2. Capitol Manufacturing Co.
  - 3. Central Plastics Company.
  - 4. Epco Sales, Inc.
  - 5. Watts Industries, Inc.; Water Products Div.
  
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
  - 1. Manufacturers:
  - 2. Advance Products & Systems, Inc.
  - 3. Calpico, Inc.
  - 4. Central Plastics Company.
  - 5. Pipeline Seal and Insulator, Inc.
  - 6. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.
  
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
  - 1. Manufacturers:
  - 2. Calpico, Inc.
  - 3. Lochinvar Corp.
  
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
  - 1. Manufacturers:
  - 2. Perfection Corp.
  - 3. Precision Plumbing Products, Inc.
  - 4. Sioux Chief Manufacturing Co., Inc.
  - 5. Victaulic Co. of America.

## **2.5 MECHANICAL SLEEVE SEALS**

- A. Refer to Division 22.

## **2.6 SLEEVES**

- A. Refer to Division 22.

## **2.7 ESCUTCHEONS**

- A. Refer to Division 22.

## **2.8 GROUT**

- A. Refer to Division 22.

## **PART 3 - EXECUTION**

### **3.1 PIPING SYSTEMS - COMMON REQUIREMENTS**

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors.
- M. Install sleeves for pipes passing through penetrations in floors, partitions, roofs, and walls.
- N. Verify final equipment locations for roughing-in.
- O. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### **3.2 PIPING JOINT CONSTRUCTION**

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

### **3.3 PIPING CONNECTIONS**

- A. Make connections according to the following, unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### **3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS**

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

- D. Install equipment to allow right of way for piping installed at required slope.

### **3.5 PAINTING**

- A. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

### **3.6 CONCRETE BASES**

- A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
  1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
  2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
  3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  5. Install anchor bolts to elevations required for proper attachment to supported equipment.
  6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
  7. Use 3000-psi (20.7-MPa) 28-day compressive-strength concrete and reinforcement as specified in Division 03.

### **3.7 GROUTING**

- A. Refer to Division 22.

**END OF SECTION 22 05 00**

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## **SECTION 22 05 13 - COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes:
  - 1. General motor requirements.
  - 2. Motor characteristics.
  - 3. Polyphase motors.
  - 4. Motors served by variable frequency controllers.
  - 5. Polyphase motors with additional requirements.
  - 6. Single phase motors.
  - 7. Motor starters.

#### **1.3 COORDINATION**

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.

### **PART 2 - PRODUCTS**

#### **2.1 GENERAL MOTOR REQUIREMENTS**

- A. Comply with NEMA MG 1 unless otherwise indicated.
- B. Comply with IEEE 841 for severe-duty motors.

#### **2.2 MOTOR CHARACTERISTICS**

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet 1000 m above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

## **2.3 POLYPHASE MOTORS**

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.
  - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
  - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F for motors with variable speed controllers. Class B for ODP motors of nominal efficiency
- J. Code Letter Designation:
  - 1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
  - 2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

## **2.4 MOTORS SERVED BY VARIABLE FREQUENCY CONTROLLERS**

- A. Motors served by variable frequency controllers (VFC) (also known as variable frequency drives VFDs shall be "inverter-duty" or "drive duty" motors. Motors shall meet or exceed all requirements of NEMA MG-1 Parts 30 and 31 for AC induction motors powered from adjustable speed controls. Use of the motor with a VFD shall not adversely affect the operation, useful life, or warranty of the motor.
- B. Motors shall have Class H insulation.
- C. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters. Motor windings shall be spike resistant to withstand a minimum of 1,600 peak volts.
- D. Motors shall have shaft grounding system to protect bearings from induced voltage. Shaft grounding system shall have very low drag, less than 1/2 percent of motor HP, and shall operate for a minimum of three (3) years without periodic adjustments. All consumables of the shaft grounding system shall be replaceable without a shutdown of the motor or VFD. The shaft grounding system shall be as manufactured by AEGIS or equal.
- E. Motors used with VFD shall have a minimum three (3) year warranty

## **2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS**

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
  - 1. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
- B. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

## **2.6 SINGLE-PHASE MOTORS**

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
  - 1. Permanent-split capacitor.
  - 2. Split phase.
  - 3. Capacitor start, inductor run.
  - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Pre-lubricated, anti-friction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

## **2.7 MOTOR STARTERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to:
  - 1. Eaton Electrical (Cutler Hammer).
  - 2. General Electric Company.
  - 3. Rockwell Automation, Inc.
  - 4. Siemens Energy and Automation.
  - 5. Square D.
- B. Provide starters for motors without variable frequency drives.
- C. Provide magnetic starter with HAND-OFF-AUTO switch (fast-slow-off-auto for two speed motors) in cover for starters that require interlocks or remote control. Provide magnetic starters, with auxiliary contacts, buttons and switches.
- D. Each three phase, 60 Hz motor shall be provide with magnetic starter with hand -off-automatic switch.
- E. Other motors shall be provided with a manual starter with on-off switch.

- F. Control relay for each starter shall be for operation on 120V, 1 phase. Provide Transformer of sufficient capacity within starter case.
- G. Provide inverse time limit overload and under voltage protection in each leg and with pilot lights. Provide red and green on/off pilot lights
- H. Provide nameplates with engraved white lettering to designate area and equipment served.
- I. Furnish for all single speed motors, 25 hp and above, 95 percent power factor correction capacitors. Capacitors shall be in NEMA enclosure of the same rating as the motor's starter.

**PART 3 - EXECUTION (Not Applicable)**

**END OF SECTION 22 05 13**

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## **SECTION 22 05 16 - EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Performance requirements
  - 2. Alignment guides and anchors.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
  - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
  - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
  - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Welding certificates.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For expansion joints to include in maintenance manuals.

#### **1.6 QUALITY ASSURANCE**

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

### **2.2 ALIGNMENT GUIDES AND ANCHORS**

#### **A. Alignment Guides**

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Flex-Hose Co., Inc.
  - b. Flexicraft Industries.
  - c. Mason Industries, Inc.
  - d. Metraflex Company (The).
  - e. U.S. Bellows, Inc.
- 2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

#### **B. Anchor Materials:**

- 1. Steel Shapes and Plates: ASTM A 36/A 36M.
- 2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
- 3. Washers: ASTM F 844, steel, plain, flat washers.
- 4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened Portland cement concrete, with tension and shear capacities appropriate for application.
  - a. Stud: Threaded, zinc-coated carbon steel.
  - b. Expansion Plug: Zinc-coated steel.
  - c. Washer and Nut: Zinc-coated steel.

## **PART 3 - EXECUTION**

### **3.1 EXPANSION JOINT INSTALLATION**

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- C. Install rubber packless expansion joints according to FSA-PSJ-703.
- D. Install grooved-joint expansion joints to grooved-end steel piping.

### **3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION**

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least four pipe fittings, including tee in main.

### **3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION**

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install one guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe, and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
  - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.
- F. fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
  - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
  - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

**END OF SECTION 22 05 16**

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## **SECTION 22 05 17 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes:
  - 1. Sleeves.
  - 2. Stack-sleeve fittings.
  - 3. Sleeve-seal systems.
  - 4. Sleeve-seal fittings.
  - 5. Grout.
  - 6. Firestopping.

#### **1.3 PENETRATION FIRE STOPPING ACTION SUBMITTALS**

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

#### **1.4 DESCRIPTION OF THE FIRE STOPPING WORK OF THIS SECTION**

- A. Only tested fire stop systems shall be used in specific locations as follows:
  - 1. Fire stop or fire seal plumbing penetrations for the passage of piping, and other equipment through fire-rated vertical barriers (walls and partitions), horizontal barriers (floor/ceiling assemblies), and vertical service shaft walls and partitions.
  - 2. Repetitive plumbing penetrations in fire-rated floor assemblies. Penetrations exist for the installation of tubs, showers, aerators and other plumbing fixtures.

#### **1.5 DEFINITIONS**

- A. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

#### **1.6 REFERENCES**

- A. Test Requirements: ASTM E 814, "Standard Method of Fire Tests of Through Penetration Fire Stops".
- B. Test Requirements: UL 1479, "Fire Tests of Through-Penetration Fire Stops".
- C. Underwriters Laboratories (UL) of Northbrook, IL publishes tested systems in their "FIRE RESISTANCE DIRECTORY" that is updated annually.

1. UL Fire Resistance Directory
  - a. Fire Stop Devices (XHJI).
  - b. Fire Resistance Ratings (BXRH).
  - c. Through-Penetration Fire Stop Systems (XHEZ).
  - d. Fill, Voids, or Cavity Material (XHHW).
  - e. Forming Materials (XHKU).
- D. International Fire Stop Council Guidelines for Evaluating Fire Stop Systems Engineering Judgments
- E. Inspection Requirements: ASTM E 2174, "Standard Practice for On-site Inspection of Installed Fire Stops".
- F. ASTM E 84, "Standard Test Method for Surface Burning Characteristics of Building Materials".
- G. All major building codes: ICBO, SBCCI, BOCA, and IBC.
- H. NFPA 101 - Life Safety Code.

## **1.7 QUALITY ASSURANCE**

- A. A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of fire stop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.
- B. Fire stop System installation must meet requirements of ASTM E814 or UL1479 tested assemblies that provide a fire rating equal to that of construction being penetrated.
- C. Proposed fire stop materials and methods shall conform to applicable governing codes having local jurisdiction.
- D. Fire stop Systems do not reestablish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural engineer prior to penetrating any load bearing assembly.
- E. For those fire stop applications that exist for which no UL tested system is available through a manufacturer, a manufacturer's engineering judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Engineering judgment drawings must follow requirements set forth by the International Fire Stop Council.

## **1.8 SUBMITTALS**

- A. Submit Product Data: Manufacturer's specifications and technical data for each material including the composition and limitations, documentation of UL fire stop systems to be used and manufacturer's installation instructions.
- B. Manufacturer's engineering judgment identification number and drawing details when no UL system is available for an application. Engineering judgment must include both project name and contractor's name who will install fire stop system as described in drawing.
- C. Submit material safety data sheets provided with product delivered to job-site.

## **1.9 INSTALLER QUALIFICATIONS**

- A. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the fire stopping manufacturer as having been provided the necessary training to install manufacturer's products per specified requirements. A manufacturer's willingness to sell its fire stopping products to the Contractor or to an Installer engaged by the Contractor does not in itself confer qualification on the buyer.
- B. Installation Responsibility: Assign installation of through-penetration fire stop systems and fire-resistive joint systems in Project to a single sole source fire stop specialty contractor.
- C. The work is to be installed by a contractor with at least one of the following qualifications:
  - 1. FM 4991 Approved Contractor.
  - 2. UL Approved Contractor.
  - 3. Hilti 3rd, Fire Spec, or Accredited Fire Stop Specialty Contractor
- D. Firm with not less than three (3) years experience with fire stop installation.
- E. Successfully completed not less than three (3) comparable scale projects using similar systems.

## **1.10 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials undamaged in manufacturer's clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.
- B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.
- C. Store materials under cover and protect from weather and damage in compliance with manufacturer's requirements.
- D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
- E. Do not use damaged or expired materials.

## **1.11 PROJECT CONDITIONS**

- A. Do not use materials that contain flammable solvents.
- B. Scheduling
  - 1. Schedule installation of CAST IN PLACE fire stop devices after completion of floor formwork, metal form deck, or composite deck but before placement of concrete.
  - 2. Schedule installation of other fire stopping materials after completion of penetrating item installation but prior to covering or concealing of openings.
- C. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
- D. Weather conditions: Do not proceed with installation of fire stop materials when temperatures exceed the manufacturer's recommended limitations for installation printed on product label and product data sheet.

- E. During installation, provide masking and drop cloths to prevent fire stopping materials from contaminating any adjacent surfaces.

## **1.12 REFERENCES**

- A. Test Requirements: ASTM E 814, "Standard Method of Fire Tests of Through Penetration Fire Stops"
- B. Test Requirements: UL 1479, "Fire Tests of Through-Penetration Fire Stops."
- C. Underwriters Laboratories (UL) of Northbrook, IL publishes tested systems in their "FIRE RESISTANCE DIRECTORY" that is updated annually.
  - 1. UL Fire Resistance Directory
    - a. Fire Stop Devices (XHJI).
    - b. Fire Resistance Ratings (BXRH).
    - c. Through-Penetration Fire stop Systems (XHEZ)
    - d. Fill, Voids, or Cavity Material (XHHW)
    - e. Forming Materials (XHKU)
- D. International Fire stop Council Guidelines for Evaluating Fire stop Systems Engineering Judgments
- E. Inspection Requirements: ASTM E 2174, "Standard Practice for On-site Inspection of Installed Fire Stops."
- F. ASTM E 84, "Standard Test Method for Surface Burning Characteristics of Building Materials."
- G. All major building codes: IBC, and NSPC.
- H. NFPA 101 - Life Safety Code

## **PART 2 - PRODUCTS**

### **2.1 SLEEVES**

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: 0.0239 inch 0.6-mm minimum thickness; round tube closed with welded longitudinal joint.

### **2.2 STACK-SLEEVE FITTINGS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Smith, Jay R. Mfg. Co.
  2. Zurn Industries, LLC.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
1. Under deck Clamp: Clamping ring with setscrews.

### **2.3 SLEEVE-SEAL SYSTEMS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. CALPICO, Inc.
  2. Link-Seal.
  3. Metraflex Company (The).
  4. Pipeline Seal and Insulator, Inc.
  5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  2. Pressure Plates: Stainless steel.
  3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

### **2.4 SLEEVE-SEAL FITTINGS**

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. HOLDRITE.
- B. Description: Manufactured plastic, sleeve-type, water stop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber water stop collar with center opening to match piping OD.

### **2.5 GROUT**

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi 34.5-MPa, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.



## 2.6 FIRESTOPPING

- A. Provide fire stopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the fire stopping under conditions of service and application, as demonstrated by the fire stopping manufacturer based on testing and field experience.
- B. Provide components for each fire stopping system that are needed to install fill material. Use only components specified by the fire stopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.
- C. Penetrations in Fire Resistance Rated Walls: Provide fire stopping with ratings determined in accordance with UL 1479 or ASTM E 814.
  - 1. F-Rating: Not less than the fire-resistance rating of the wall construction being penetrated.
- D. Penetrations in Horizontal Assemblies: Provide fire stopping with ratings determined in accordance with UL 1479 or ASTM E 814.
  - 1. F-Rating: Minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
  - 2. T-Rating: When penetrant is located outside of a wall cavity, minimum of 1-hour rating, but not less than the fire-resistance rating of the floor construction being penetrated.
- E. Penetrations in Smoke Barriers: Provide fire stopping with ratings determined in accordance with UL 1479 or ASTM E 814.
  - 1. L-Rating: Not exceeding 5.0 cfm/sf of penetration opening at both ambient and elevated temperatures.
- F. Mold Resistance: Provide penetration fire stopping with mold and mildew resistance rating of 0 as determined by ASTM G21.
- G. Acceptable Manufacturers
  - 1. Subject to compliance with through penetration fire stop systems (XHEZ) listed in Volume II of the UL Fire Resistance Directory, provide products of the following manufacturers as identified below:
    - a. Hilti, Inc.
- H. Materials
  - 1. Use only fire stop products that have been UL 1479 or ASTM E 814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.
  - 2. Pre-installed fire stop devices for use with noncombustible and combustible pipes (closed and open systems) penetrating concrete floors and/or gypsum walls, the following products are acceptable:
    - a. Hilti Cast-In Place Fire Stop Device (CP 680-P).
      - 1) Add Aerator Adaptor when used in conjunction with aerator system.
    - b. Hilti Tub Box Kit (CP 681) for use with tub installations.
    - c. Hilti Cast-In Place Fire Stop Device (CP 680-M) for use with noncombustible penetrants.
    - d. Hilti Fire Stop Speed Sleeve (CP 653) for use with cable penetrations.

- e. Hilti Fire stop Drop-In Device (CFS-DID) for use with noncombustible and combustible penetrants.
  - f. Hilti Fire stop Block (CFS-BL).
3. Sealants, caulking materials, or foams for use with non-combustible items including steel pipe, copper pipe, rigid steel conduit and electrical metallic tubing (EMT), the following products are acceptable:
    - a. Hilti Intumescent Fire Stop Sealant (FS-ONE MAX).
    - b. Hilti Fire Foam (CP 620).
    - c. Hilti Flexible Fire Stop Sealant (CP 606).
  4. Intumescent sealants, caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe, PVC jacketed, flexible cable or cable bundles and plastic pipe, the following products are acceptable:
    - a. Hilti Intumescent Fire Stop Sealant (FS-ONE MAX).
  5. Foams, intumescent sealants, or caulking materials for use with flexible cable or cable bundles, the following products are acceptable:
    - a. Hilti Intumescent Fire Stop Sealant (FS-ONE MAX).
    - b. Hilti Fire Foam (CP 620).
    - c. Hilti Flexible Fire Stop Sealant (CP 606).
  6. Non-curing, re-penetrable, intumescent putty or foam materials for use with flexible cable or cable bundles, the following products are acceptable:
    - a. Hilti Fire Stop Putty Stick (CP 618).
    - b. Hilti Fire Stop Plug (CFS-PL).
  7. Fire stop collar or wrap devices attached to assembly around combustible plastic pipe (closed and open piping systems), the following products are acceptable:
    - a. Hilti Fire Stop Collar (CP 643N).
    - b. Hilti Fire Stop Collar (CP 644).
    - c. Hilti Wrap Strips (CP 648E / 648S).
  8. Materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
    - a. Hilti Fire Stop Mortar (CP 637).
    - b. Hilti Fire Stop Block (CFS-BL).
    - c. Hilti Fire Foam (CP 620).
    - d. Hilti Fire Stop Board (CP 675T).
  9. Non curing, re-penetrable materials used for large openings and complex penetrations made to accommodate cable trays and bundles, multiple steel and copper pipes, electrical busways in raceways, the following products are acceptable:
    - a. Hilti Fire Stop Block (CFS-BL).
    - b. Hilti Fire Stop Board (CP 675T).
  10. For blank openings made in fire-rated wall or floor assemblies, where future penetration of pipes, conduits, or cables is expected, the following products are acceptable:
    - a. Hilti Fire Stop Block (CFS-BL).

- b. Hilti Fire Stop Plug (CFS-PL).
11. Provide a fire stop system with a "F" Rating as determined by UL 1479 or ASTM E 814 which is equal to the time rating of construction being penetrated.

## **PART 3 - EXECUTION**

### **3.1 SLEEVE INSTALLATION**

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1 inch 25-mm annular clear space between piping and concrete slabs and walls.
  - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors 2 inches 50 mm above finished floor level in the following areas:
      - 1) Mechanical equipment areas
      - 2) Or other wet areas
  - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
  - 2. Install sleeves that are large enough to provide 1/4 inch 6.4-mm annular clear space between sleeve and pipe or pipe insulation.
  - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07.
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Comply with requirements for fire stopping specified in Division 07.

### **3.2 STACK-SLEEVE-FITTING INSTALLATION**

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
  - 1. Install fittings that are large enough to provide 1/4 inch 6.4-mm annular clear space between sleeve and pipe or pipe insulation.
  - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07.
  - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches 50 mm above finished floor level.
  - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with fire stop materials. Comply with requirements for fire stopping specified in Division 07.

### **3.3 SLEEVE-SEAL-SYSTEM INSTALLATION**

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

### **3.4 SLEEVE-SEAL-FITTING INSTALLATION**

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

### **3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE**

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
1. Exterior Concrete Walls above Grade:
    - a. Piping Smaller Than NPS 6 DN 150: Galvanized-steel wall sleeves. Sleeve-seal fittings.
    - b. Piping NPS 6 DN 150 and Larger: Galvanized-steel wall sleeves. Insert material.
  2. Exterior Concrete Walls below Grade:
    - a. Piping Smaller Than NPS 6 DN 150: Galvanized-steel wall sleeves with sleeve-seal system sleeve-seal fittings
      - 1) Select sleeve size to allow for 1 inch 25-mm annular clear space between piping and sleeve for installing sleeve-seal system.
    - b. Piping NPS 6 DN 150: Galvanized-steel wall sleeves with sleeve-seal system
      - 1) Select sleeve size to allow for 1 inch 25-mm annular clear space between piping and sleeve for installing sleeve-seal system.
  3. Concrete Slabs-on-Grade:
    - a. Piping Smaller Than NPS 6 DN 150: Galvanized-steel wall sleeves with sleeve-seal system Galvanized-steel-pipe sleeves with sleeve-seal system

4. Concrete Slabs above Grade:
  - a. Piping Smaller Than NPS 6 DN 150 Insert pipe size: Galvanized-steel-pipe sleeves
  - b. Piping NPS 6 DN 150 Insert pipe size and Larger: Galvanized-steel-pipe sleeves  
Stack-sleeve fittings
5. Interior Partitions:
  - a. Piping Smaller Than NPS 6 DN 150: Galvanized-steel-pipe sleeves.
  - b. Piping NPS 6 DN 150 and Larger: Galvanized-steel-sheet sleeves.

### 3.6 FIRE STOPPING INSTALLATION

#### A. Preparation

1. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
  - a. Verify penetrations are properly sized and in suitable condition for application of materials.
  - b. Surfaces to which fire stop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.
  - c. Provide masking and temporary covering to prevent soiling of adjacent surfaces by fire stopping materials.
  - d. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of fire stopping.
  - e. Do not proceed until unsatisfactory conditions have been corrected.

#### B. Coordination

1. Coordinate location and proper selection of cast-in-place Fire Stop Devices with trade responsible for the work. Ensure device is installed before placement of concrete.
2. Responsible trade to provide adequate spacing of field runs pipes to allow for installation of cast-in-place fire stop devices without interferences.

#### C. Installation

1. Regulatory Requirements: Install fire stop materials in accordance with UL Fire Resistance Directory.
2. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration joint materials.
  - a. Seal all holes or voids made by penetrations to ensure an air and water resistant seal.
  - b. Consult with mechanical engineer, project manager, and damper manufacturer prior to installation of UL fire stop systems that might hamper the performance of fire dampers as it pertains to ductwork.
  - c. Protect materials from damage on surfaces subjected to traffic.

#### D. Field Quality Control

1. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas.
2. Keep areas of work accessible until inspection by applicable code authorities.
3. Inspection of through-penetration fire stopping shall be performed in accordance with ASTM E 2174, "Standard Practice for On-Site Inspection of Installed Fire Stops" or other recognized standard.

4. Perform under this section patching and repairing of fire stopping caused by cutting or penetrating of existing fire stop systems already installed by other trades.

E. Identification and Documentation

1. The fire stop contractor is to supply documentation for each single application addressed. This documentation is to identify each penetration location on the entire project.
  - a. The Documentation Form for through penetrations is to include:
    - 1) A Sequential Location Number
    - 2) The Project Name
    - 3) Date of Installation
    - 4) Detailed description of the penetrations location
    - 5) Tested System or Engineered Judgment Number
    - 6) Type of assembly penetrated
    - 7) A detailed description of the size and type of penetrating item
    - 8) Size of opening
    - 9) Number of sides of assemblies addressed
    - 10) Hourly rating to be achieved
    - 11) Installers Name
2. Copies of these documents are to be provided to the general contractor at the completion of the project.
3. Identify through-penetration fire stop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each fire stop system installation where labels will be visible to anyone seeking to remove penetrating items or fire stop systems. Include the following information on labels:
  - a. The words: "Warning -Through Penetration Fire stop System-Do Not Disturb. Notify Building Management of Any Damage."
  - b. Contractor's Name, address, and phone number.
  - c. Through-Penetration firestop system designation of applicable testing and inspecting agency.
  - d. Date of Installation.
  - e. Through-Penetration fire stop system manufacturer's name.
  - f. Installer's Name.

F. Fire stop documentation manager software shall be used to document, track, and maintain the passive fire stop systems throughout the construction and maintenance phase of the facility. The software solution shall be used to track and document every fire stop system installed on the project and each subsequent addition, change, or removal of the fire stop system. The fire stop documentation shall be managed with cloud-based software which allows the installer to use a standard Smartphone or tablet device (either iOS, Android or Windows capable) to capture the relevant information for the installation. The following data shall be tracked for each penetration within the facility: product installed, system installed, date of installation, location of the penetration including a notation on the 2D plan image, F-rating, name of installer, photo (pre-installation and post-installation), and inspection status. The Owner and/ or Construction Manager may designate additional items to be tracked. The fire stop documentation manager software must perform the following basic functions:

1. Create multiple projects/ facilities, add/create/ remove users for each project, upload documents including UL systems, 2D floor plans, product data, engineering judgments, etc.
2. Define data to track using pre-defined input fields or creating custom input fields as desired.
3. Capture multiple photos for each penetration, including a pre-installation and post-installation photo.
4. Scan QR Code on Hilti identification label to link the program data to a specific penetration location.

5. Annotate (mark) location of penetration on 2D floor plan.
  6. Create reports by filtering data and utilizing report templates.
  7. Online/ offline (for use in areas where data service is unavailable) synchronization of data between mobile device, online application and cloud-based system.
  8. Ability to transfer ownership of projects from one customer to another from construction phase to facility maintenance.
- G. Permanently attach Hilti identification labels to surfaces adjacent to and within 6 inches (150 mm) of fire stopping edge so labels will be visible to anyone seeking to remove or change penetrating items or fire stopping. Labels shall have a unique QR code for each penetration which can be scanned by the fire stop documentation software to quickly identify the penetration attributes.
- H. Acceptable Software: Hilti CFS-DM, from Hilti Inc., Tulsa, OK. Tel: (800) 879-8000 website: [www.us.hilti.com](http://www.us.hilti.com)
1. Substitutions: Upon submission.
  2. Single Source: Obtain fire stop documentation manager software and fire stop systems for each type of penetration and construction condition indicated only from a single manufacturer.
- I. Adjusting and Cleaning
1. Remove equipment, materials and debris, leaving area in undamaged, clean condition.
  2. Clean all surfaces adjacent to sealed holes and joints to be free of excess fire stop materials and soiling as work progresses.
- J. Labor Use to Install Fire Stop Systems
1. To ensure complete harmony on the project site, the installation of each scope of work is to be performed jurisdictionally correct per existing trade agreements.

### 3.7 FIRESTOP SCHEDULE

CONCRETE FLOORS			CONCRETE OR BLOCK WALLS		
TYPE OF PENETRANT	F-RATING (HR)	UL-CLASSIFIED SYSTEM	TYPE OF PENETRANT	F-RATING (HR)	UL-CLASSIFIED SYSTEM
CIRCULAR BLANK OPENINGS	1	FA 0006,CAJ 0055,CAJ 0090	CIRCULAR BLANK OPENINGS	1	CAJ 0055, CAJ 0090
	2	FA 0006,CAJ 0055,CAJ 0090		2	CAJ 0055, CAJ 0090
	3	FA 0006, CAJ 0055, CAJ 0086, FA 0014		3	CAJ 0055, CAJ 0086
SINGLE METAL PIPES OR CONDUIT	1	CAJ 1226, FA 1028	SINGLE METAL PIPES OR CONDUIT	1	CAJ 1226, WJ 1067
	2	CAJ 1155, CAJ 1291, CAJ 1226, FA 1016, FA 1028, FA 1106, FB1010		2	CAJ 1226, CAJ 1155, CAJ 1291, WJ 1067
	3	CAJ 1155, CAJ 1226, FA 1017, FB 1009		3	CAJ 1226, CAJ 1155, WJ 1041, WJ 1068
	4	CBJ 1037, CBJ 1034, FA 1091		4	CBJ 1034, CBJ 1037, WJ 1041, WJ 1042, WJ 1068
SINGLE NON-METALLIC PIPE OR CONDUIT (I.E. PVC, CPVC, ABS, FRP, ENT)	1	FA 2053, FA 2025, CAJ 2109, CAJ 2098, CAJ 2271, CAJ 2167, CBJ 2021, CAJ 2342	SINGLE NON-METALLIC PIPE OR CONDUIT (I.E. PVC, CPVC, ABS, FRP, ENT)	1	CAJ 2109, CAJ 2098, CAJ 2167, CAJ 2371, CAJ 2342
	2	FA 2053, FA 2025, FA 2092, CAJ 2109, CAJ 2098, CAJ 2271, CAJ 2167, CAJ 2218, CAJ 2488, CAJ 2570, CBJ-2021, CAJ 2284, CAJ 2371, CAJ 2342		2	CAJ 2109, CAJ 2098, CAJ 2167, CAJ 2218, CAJ 2488, CAJ 2570, CAJ 2371, CAJ 2342
	3	FA 2054, FA 2071, FA 2213, FB 2048, CAJ 2098, CAJ 2109, CAJ 2168, CAJ 2371, CAJ 2342, CAJ 2420		3	CAJ 2109, CAJ 2098, CAJ 2168, CAJ 2371, CAJ 2342
	4	CBJ 2016, CAJ 2017		4	WJ 2057, WJ 2091
SINGLE OR BUNDLED CABLES	1	FA 3007,CAJ 3095,CAJ 3180	SINGLE OR BUNDLED CABLES	1	WJ 3036, CAJ 3095, CAJ 3180, WJ 3060
	2	FA 3007,CAJ 3095,CAJ 3180		2	WJ 3036, CAJ 3095, CAJ 3180, CAJ 3281, WJ 3060
	3	FA 3007,CAJ 3095,CAJ 3180		3	CAJ 3095, CAJ 3180, CAJ 3285
SINGLE INSULATED PIPES	1	FA 5015, FA 5017, CAJ 5090, CAJ 5091, CAJ 5098	SINGLE INSULATED PIPES	1	CAJ 5090, CAJ 5091, CAJ 5061, WJ 5042
	2	FA 5015, FA 5017, CAJ 5090, CAJ 5091, CAJ5090		2	CAJ 5090, CAJ 5091, CAJ 5061, WJ 5042
	3	FA 5016, CAJ 5090, FA 5018		3	CAJ 5090, CAJ 5061
	4	CBJ 5006		4	CBJ 5006, WJ 5028
MIXED PENETRANTS	1	CAJ 8099, CAJ 8056, CAJ 8143	MIXED PENETRANTS	1	CAJ 8099, CAJ 8056, WJ 8007, CAJ 8143
	2	CAJ 8099, CAJ 8056, CAJ 8143		2	CAJ 8099, CAJ 8056, WJ 8007, CAJ 8143
	3	CAJ 8099, CAJ 8056		3	CAJ 8041, CAJ 8056, WJ 8007, CAJ 8099
	4	CAJ 8095		4	CAJ 8095, WJ 8007
WOOD FLOOR			GYPSUM WALL BOARD ASSEMBLIES		
TYPE OF PENETRANT	F-RATING (HR)	UL-CLASSIFIED SYSTEM	TYPE OF PENETRANT	F-RATING	UL-CLASSIFIED SYSTEM
METAL PIPES OR CONDUIT	1	FC 1009, FC 1059	METAL PIPES OR CONDUIT	1	WL 1054, WL 1058, WL 1164
	2	FC 1009, FC 1059		2	WL 1054, WL 1058, WL 1164
				4	WL 1110, WL 1111, WL 1165
NON-METALLIC PIPE OR CONDUIT	1	FC 2232, FC 2030, FC 2071, FC 2160, FC 2127, FC 2128, FC 2389	NON-METALLIC PIPE OR CONDUIT	1	WL 2078, WL 2075, WL 2078, WL 2098, WL 2377, WL 2406, WL2341, WL 2128
	2	FC 2029, FC 2030, FC2071, FC 2128, FC 2127, FC 2160		2	WL 2078, WL 2075, WL 2078, WL 2098, WL 2377, WL 2406, WL2341, WL 2128
SINGLE OR BUNDLED CABLES	1	FC 3012, FC 3044	SINGLE OR BUNDLED CABLES	1	WL 3065, WL 3111, WL 3112
	2	FC 3012		2	WL 3065, WL 3111, WL 3112, WL 3334, WL 3335, WL 3384, WL 3395
				4	WL 3139
INSULATED PIPES	1	FC 5004, FC 5037, FC 5036	CABLE TRAY	1	WL 4011, WL 4019
	2	FC 5004, FC 5037		2	WL 4011, WL 4019
MIXED PENETRANTS	1	FC 8009, FC 8014, FC 8026, FC8025	INSULATED PIPES	4	WL 8014
				1	WL 5028, WL 5029, WL 5047, WL 5096
			MIXED PENETRANTS	2	WL 5028, WL 5029, WL 5027, WL 5096, WL 5047
				4	WL 5073
				1	WL 1095, WL 8013
				2	WL 1095, WL 8013
				4	WL 8014

\*\*CONTACT HILTI FOR CURRENT UL-CLASSIFIED SYSTEM OR ENGINEER JUDGMENT DRAWING: 800-879-6000

**NOTES:**

1. Jobsite conditions of each through-penetration firestop system must meet ALL details of the UL-Classified System selected.
2. If jobsite conditions do not match any UL-classified systems in the schedules above, contact Hilti for alternative systems or Engineer Judgment Drawings - 800-879-8000
3. Where more than one applicable UL-Classified System is listed in the schedules, choose the UL System which is most economical for each through-penetration firestop system.
4. Coordinate work with other trades to assure that penetration opening sizes are appropriate for penetrant locations, and vice versa.
5. For 3-hour rated gypsum walls, contact Hilti for a UL-classified system or engineer judgment drawing - 800-879-8000.

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## **SECTION 22 05 18 - ESCUTCHEONS FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes:
  - 1. Escutcheons.
  - 2. Floor plates.

#### **1.3 ACTION SUBMITTALS**

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

### **PART 2 - PRODUCTS**

#### **2.1 ESCUTCHEONS**

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed and exposed-rivet hinge, and spring-clip fasteners.

#### **2.2 FLOOR PLATES**

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
    - c. Insulated Piping: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
    - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
    - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
    - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
    - g. Bare Piping in Equipment Rooms: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. New Piping: One-piece, floor-plate type.
  - 2. Existing Piping: Split-casting, floor-plate type.

### **3.2 FIELD QUALITY CONTROL**

- A. Replace broken and damaged escutcheons and floor plates using new materials.

**END OF SECTION 22 05 18**

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## **SECTION 22 05 19 - METERS AND GAGES FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes:
  - 1. Filled-system thermometers.
  - 2. Liquid-in-glass thermometers.
  - 3. Thermowells.
  - 4. Pressure gages.
  - 5. Gage attachments.
  - 6. Test plugs.
  - 7. Test-plug kits.
  - 8. Sight flow indicators.
  - 9. Water meters.

#### **1.3 ACTION SUBMITTALS**

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

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Product Certificates: For each type of meter and gage, from manufacturer.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

### **PART 2 - PRODUCTS**

#### **2.1 FILLED-SYSTEM THERMOMETERS**

- A. Direct-Mounted, Stainless steel case, Vapor-Actuated Thermometers:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Ashcroft.
    - b. Marsh Bellofram.
    - c. Terice, HO Co.

- d. WIKA Instrument Corporation.
2. Standard: ASME B40.200.
  3. Case: Stainless steel, 4.5 inches.
  4. Dial: White coated aluminum with black markings
  5. Pointer: Adjustable, balance, aluminum with matte black finish.
  6. Window: Glass or Lexan
  7. Ring: Stainless steel
  8. Connector Type(s): Union, Thermowell, or plain bulb. At system plain or union bulb. Copper or 316 stainless steel.
  9. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
- a. Design for Thermowell Installation: Bare stem.
10. Accuracy: Plus or minus 1 percent of scale range.
  11. Basis of Design: WIKA Instruments T1.V45

## 2.2 LIQUID-IN-GLASS THERMOMETERS

### A. Stainless -Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    - a. Ashcroft.
    - b. Marsh Bellofram.
    - c. WIKA Instrument Corporation.
    - d. Terrice, HO Co.
  2. Standard: ASME B40.200.
  3. Case: Plastic; 6 inch 152-mm nominal size.
  4. Case Form: Back angle straight unless otherwise indicated.
  5. Tube: Glass with magnifying lens and blue (or red) organic liquid.
  6. Tube Background: Non-reflective with permanently etched scale markings graduated in deg F and deg C.
  7. Window: Glass or plastic.
  8. Stem: brass: length to suit installation.
- a. Design for Thermowell Installation: Bare stem.
9. Connector: 3/4 inch 19 mm, with ASME B1.1 screw threads.
  10. Accuracy: plus or minus 1.0 percent of span.
  11. Basis of Design: WIKA Instruments T1.901 or T1.701

## 2.3 THERMOWELLS

### A. General

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Material for Use with Steel Piping: CRES CSA.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, DN 15, DN 20, or NPS 25, ASME B1.20.1 pipe threads.

7. Internal Threads: 1/2 inch, 3/4 inch, and 1 inch 13, 19, and 25 mm, with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required matching thermometer bulb or stemming.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowells internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

## 2.4 PRESSURE GAGES

A. Direct-Mounted, Stainless-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. AMETEK, Inc.
  - b. Ashcroft Inc.
  - c. Marsh Bellofram.
  - d. Watts; a Watts Water Technologies company.
  - e. WIKA Instrument Corporation.
  - f. Weiss Instruments, Inc.
2. Standard: ASME B40.100.
3. Case: Stainless steel, 4.5 inches.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 DN 8, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: White aluminum with stop pin and black lettering.
8. Pointer: Black aluminum.
9. Window: Snap-in poly carbonate
10. Accuracy: plus or minus 1.0 percent of span (ASME B40.100, grade 1A)
11. Basis of Design: WIKA Instruments model 111.25CT

## 2.5 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 DN 8 NPS 1/4 or NPS 1/2 DN 8 or DN 15 NPS 1/2 DN 15, ASME B1.20.1 pipe threads and piston porous-metal-type surge-dampening device. Include extension for use on insulated piping.
1. Basis of Design: WIKA Instrument model 910.12.X00
- B. Valves: Brass ball Brass or stainless-steel needle, with NPS 1/4 DN 8 NPS 1/4 or NPS 1/2 DN 8 or DN 15 NPS 1/2 DN 15, ASME B1.20.1 pipe threads.
1. Basis of Design: WIKA Instrument model 910.11.100

## 2.6 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. National Meter, Inc.
  2. Watts; a Watts Water Technologies company.
  3. WIKA Instrument Corporation.
4. Weiss Instruments, Inc.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 DN 8 or NPS 1/2 DN 15, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F 3450 kPa at 93 deg C.
- F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.
- G. Basis of Design: WIKA Instrument model 910.14.100

## 2.7 TEST-PLUG KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following
1. National Meter, Inc.
  2. Trerice, H. O. Co.
  3. WIKA Instrument Corporation.
  4. Weiss Instruments, Inc.
- B. Furnish two test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch 25- to 51-mm- diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F minus 4 to plus 52 deg C.
- D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- 25- to 51-mm- diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F minus 18 to plus 104 deg C.
- E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- 51- to 76-mm-diameter dial and probe. Dial range shall be at least 0 to 200 psig 0 to 1380 kPa.
- F. Carrying Case: Metal or plastic, with formed instrument padding.

## 2.8 SIGHT FLOW INDICATORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Dwyer Instruments, Inc.
  2. Emerson Process Management; Rosemount Division.

3. Ernst Flow Industries.
  4. KOBOLD Instruments, Inc. - USA.
- B. Description: Piping inline-installation device for visual verification of flow.
  - C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
  - D. Minimum Pressure Rating: 125 psig 860 kPa.
  - E. Minimum Temperature Rating: 200 deg F 93 deg C.
  - F. End Connections for NPS 2 DN 50 and Smaller: Threaded.
  - G. End Connections for NPS 2-1/2 DN 65 and Larger: Flanged.

## 2.9 WATER METERS

- A. Compound-Type Water Meters
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. ABB.
    - b. Badger Industries, Inc.
    - c. Master Meter, Inc.
    - d. Mueller Co.
    - e. Schlumberger Limited.
  2. Description
    - a. Standard: AWWA C702.
    - b. Pressure Rating: 150-psig 1035-kPa working pressure.
    - c. Body Design: With integral mainline and bypass meters; totalization meter.
    - d. Registration: In gallons liters or cubic feet cubic meters as required by utility company.
    - e. Case: Bronze.
    - f. Pipe Connections: Flanged.
- B. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal-transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install thermowells with socket extending one-third of pipe diameter and in vertical position in piping tees.

- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- H. Install remote-mounted pressure gages on panel.
- I. Install valve and snubber in piping for each pressure gage for fluids.
- J. Install test plugs in piping tees.
- K. Install thermometers in the following locations:
  - 1. Inlet and outlet of each water heater.
  - 2. Inlet and outlet of mixing valves.
  - 3. Inlet of hot water recirculation pumps.
  - 4. At each hot water balancing station.
- L. Install pressure gages in the following locations:
  - 1. Building water service entrance into building.
  - 2. Inlet and outlet of each pressure-reducing valve.
  - 3. Outlet of each hot water recirculation pump.
  - 4. Top of each water riser.
  - 5. Inlet and outlet of master mixing valves.

### **3.2 CONNECTIONS**

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.

### **3.3 ADJUSTING**

- A. Adjust faces of meters and gages to proper angle for best visibility.

### **3.4 THERMOMETER SCHEDULE**

- A. Thermometers at inlet and outlet of each water heaters shall be one of the following:
  - 1. Liquid-filled, sealed, bimetallic-actuated type.
  - 2. Direct-mounted, plastic-case, vapor-actuated type.
  - 3. Industrial-style, liquid-in-glass type.
  - 4. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.



- B. Thermometers at inlet and outlet of each hot water recirculation pump shall be one of the following:
  1. Liquid-filled, sealed, bimetallic-actuated type.
  2. Direct remote-mounted, plastic-case, vapor-actuated type.
  3. Compact Industrial-style, liquid-in-glass type.
  4. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.
- C. Thermometers at inlet and outlet of each hot water Master Mixing Station shall be one of the following:
  1. Compact Industrial-style, liquid-in-glass type.
  2. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.
- D. Thermometer stems shall be of length to match thermowell insertion length.

### **3.5 THERMOMETER SCALE-RANGE SCHEDULE**

- A. Scale Range for Cold-Water Piping: 0 to 150 deg F Minus 20 to plus 70 deg C 0 to 150 deg F and minus 20 to plus 70 deg C.
- B. Scale Range for Hot-Water Piping: 0 to 250 deg F 0 to 150 deg C

### **3.6 PRESSURE-GAGE SCHEDULE**

- A. Pressure gages at discharge of each water service into building shall be the following:
  1. Sealed, direct -mounted, plastic case.
- B. Pressure gages at inlet and outlet of each water pressure-reducing valve shall be the following:
  1. Sealed, direct-mounted, plastic case.
  2. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.
- C. Pressure gages at suction and discharge of each water pump shall be one of the following:
  1. Liquid-filled, sealed open-front, pressure-relief solid-front, pressure-relief, direct-mounted, metal case.
  2. Sealed, direct-mounted, plastic case.
  3. Test plug with chlorosulfonated polyethylene synthetic EPDM self-sealing rubber inserts.

### **3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE**

- A. Scale Range for Water Service Piping: 0 to 160 psi 0 to 1100 kPa and 0 to 1100 kPa.

**END OF SECTION 22 05 19**

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## **SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes
  - 1. Metal pipe hangers and supports.
  - 2. Trapeze pipe hangers.
  - 3. Metal framing systems.
  - 4. Thermal-hanger shield inserts.
  - 5. Fastener systems.
  - 6. Pipe stands.
  - 7. Pipe positioning systems.
  - 8. Equipment supports.
  - 9. Miscellaneous materials.
  - 10. Acoustical isolation hangers and supports
- B. Related Sections
  - 1. Division 05 for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

#### **1.3 DEFINITIONS**

- A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
  - 1. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
  - 2. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

#### **1.5 ACTION SUBMITTALS**

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

- B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
  - 1. Trapeze pipe hangers.
  - 2. Metal framing systems.
  - 3. Pipe stands.
  - 4. Equipment supports.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

## 1.7 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

## PART 2 - PRODUCTS

### 2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  - 2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
  - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
  - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
  - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Stainless-Steel Pipe Hangers and Supports
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
  - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- C. Copper Pipe Hangers
  - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
  - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

### 2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

## 2.3 METAL FRAMING SYSTEMS

### A. MFMA Manufacturer Metal Framing Systems

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
2. Standard: MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Metallic Coating: Electroplated zinc hot-dipped galvanized mill galvanized in-line, hot galvanized mechanically-deposited zinc.

### B. Non-MFMA Manufacturer Metal Framing Systems

1. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
2. Standard: Comply with MFMA-4.
3. Channels: Continuous slotted steel channel with inturned lips.
4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
6. Coating: Zinc.

## 2.4 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless- steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- B. Internally Threaded Anchor for Installation into Metal Deck: Concrete anchor shall be carbon steel, cast-in type with single internal thread and a zinc/yellow chromate plating. Anchor shall have a protective sleeve, steel flange with pre-drilled additional fastening holes and placement spring for attachment to metal deck, anchor is to be secured by clamping the deck between the steel flange and the protective plastic sleeve. Anchor shall bear the diameter and the manufacturer name on hexagonal head.
- C. Internally Threaded Anchor for Installation into Wood Deck: Concrete anchor shall be carbon steel, cast-in type with single internal thread and a zinc/yellow chromate plating and contained by a plastic flange. Anchor shall have break-off nails for attachment to the surface of wood forms. Anchor will bear the diameter and manufacturer name on hexagonal head.

## 2.5 PIPE STANDS

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
- C. Low-Type, Single-Pipe Stand: One-piece plastic or stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
- D. High-Type, Single-Pipe Stand

1. Description: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
  2. Base: Stainless steel.
  3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
  4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.
- E. High-Type, Multiple-Pipe Stand
1. Description: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
  2. Bases: One or more; plastic.
  3. Vertical Members: Two or more protective-coated-steel channels.
  4. Horizontal Member: Protective-coated-steel channel.
  5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

## **2.6 PIPE POSITIONING SYSTEMS**

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

## **2.7 EQUIPMENT SUPPORTS**

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

## **2.8 MISCELLANEOUS MATERIALS**

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, non-shrink and non-metallic grout; suitable for interior and exterior applications.
1. Properties: Non-staining, noncorrosive, and nongaseous.
  2. Design Mix: 5000-psi 34.5-MPa, 28-day compressive strength.

## **PART 3 - EXECUTION**

### **3.1 HANGER AND SUPPORT INSTALLATION**

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89 and local codes. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
  2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation
1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation
1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
  2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 for curbs.
- G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- J. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- K. Install lateral bracing with pipe hangers and supports to prevent swaying.
- L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 DN 65 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- M. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- O. Insulated Piping
1. Attach clamps and spacers to piping.
    - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.

2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 DN 100 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 DN 100 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
  - a. NPS 1/4 to NPS 3-1/2 DN 8 to DN 90: 12 inches 305 mm long and 0.048 inch 1.22 mm thick.
  - b. NPS 4 DN 100: 12 inches 305 mm long and 0.06 inch 1.52 mm thick.
  - c. NPS 5 and NPS 6 DN 125 and DN 150: 18 inches 457 mm long and 0.06 inch 1.52 mm thick.
  - d. NPS 8 to NPS 14 DN 200 to DN 350: 24 inches 610 mm long and 0.075 inch 1.91 mm thick.
  - e. NPS 16 to NPS 24 DN 400 to DN 600: 24 inches 610 mm long and 0.105 inch 2.67 mm thick.
5. Pipes NPS 8 DN 200 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
7. Support of pipe, tubing and equipment shall be accomplished by means of engineered products, specific to each application. Makeshift, field devised methods are not allowed.
8. Comply with CISPI Designation 310-04, CISPI Designation 301-09 and the CISPI Cast Iron Soil Pipe Handbook, regarding auxiliary support for ho-hub cast iron pipe and fitting joints subjected to excessive thrust forces. Use manufactured assemblies with appropriate thrust pressure ratings, rather than field assembled miscellaneous materials.
9. No-hub pipe and fitting coupling joints that are exposed to thrust pressures greater than those recommended by the pipe and fitting manufacturer shall receive auxiliary support by means of appropriate bracing materials, as referred to in CISPI Designation 310-04, CIPSI Designation 301-09 and the CISPI Cast Iron Soil Pipe and Fittings Handbook. Auxiliary restraint products used shall be manufactured assemblies with thrust pressure rating adequate for the specific installation and shall be installed onto horizontal joints NPS 4 (DN 100) diameter and larger in size. Field devised methods and materials shall not be used to accomplish this application solution.

### **3.2 PAINTING**

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils 0.05 mm.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 for painting.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

### 3.3 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and fiberglass pipe hangers and fiberglass strut systems and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of non-insulated or insulated, stationary pipes NPS 1/2 to NPS 30 DN 15 to DN 750.
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F 566 deg C, pipes NPS 4 to NPS 24 DN 100 to DN 600, requiring up to 4 inches 100 mm of insulation.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36 DN 20 to DN 900, requiring clamp flexibility and up to 4 inches 100 mm of insulation.
  - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 DN 15 to DN 600 if little or no insulation is required.
  - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4 DN 15 to DN 100, to allow off-center closure for hanger installation before pipe erection.
  - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of non-insulated, stationary pipes NPS 3/4 to NPS 8 DN 20 to DN 200.
  - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8 DN 15 to DN 200.
  - 8. Adjustable Band Hangers (MSS Type 9): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8 DN 15 to DN 200.
  - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of non-insulated, stationary pipes NPS 1/2 to NPS 8 DN 15 to DN 200.
  - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 8 DN 10 to DN 200.
  - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of non-insulated, stationary pipes NPS 3/8 to NPS 3 DN 10 to DN 80.
  - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 DN 15 to DN 750.
  - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  - 14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 DN 100 to DN 900, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.



15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 DN 100 to DN 900, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 DN 65 to DN 900 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
  17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30 DN 25 to DN 750, from two rods if longitudinal movement caused by expansion and contraction might occur.
  18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 DN 65 to DN 600, from single rod if horizontal movement caused by expansion and contraction might occur.
  19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 DN 50 to DN 1050 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
  20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 DN 50 to DN 600 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
  21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 DN 50 to DN 750 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 DN 24 to DN 600.
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 DN 20 to DN 600 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches 150 mm for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F 49 to 232 deg C piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
  4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F 49 to 232 deg C piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

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9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb 340 kg.
    - b. Medium (MSS Type 32): 1500 lb 680 kg.
    - c. Heavy (MSS Type 33): 3000 lb 1360 kg.
  13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches 32 mm.
  3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
  4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
  6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
  7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
  8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - a. Horizontal (MSS Type 54): Mounted horizontally.
    - b. Vertical (MSS Type 55): Mounted vertically.
    - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

- R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.
- S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

### **3.4 SPACING**

- A. Refer to individual piping sections for spacing requirements.
- B. Where no requirement is specified elsewhere, pipe hangers and supports shall be per MSS SP-90.
- C. Space pipe hangers and supports in accordance with following tables, with exceptions as indicated herein.
- D. The vertical spacing shall be at each floor level, with spacing not to exceed that shown in the table below.

Table 1 – Maximum Horizontal Pipe Hanger and Support Spacing

NOMINAL PIPE OR TUBE SIZE		1		2		3		4		6	7
		STD WT STEEL PIPE				COPPER TUBE					
		WATER SERVICE		VAPOR SERVICE		WATER SERVICE		VAPOR SERVICE			
in.	mm	ft.	m	ft.	m	ft.	mm	ft.	m		
1/4	(6)					5	1.5	4	1.2	10 FT. (3.0m) MAX SPACING.	5 FT. (3.0m) MAX SPACING EXCEPT MAY INCREASE TO 10 FT. WHERE 10 FOOT LENGTHS ARE INSTALLED. MIN OF ONE (1) HANGER PER PIPE SECTION CLOSE TO JOINT ON THE BARREL. ALSO AT CHANGE OF DIRECTION AND BRANCH CONNECTIONS.
3/8	(10)	7	2.1	6	1.8	5	1.5	4	1.2		
1/2	(15)	7	2.1	6	1.8	5	1.5	4	1.2		
3/4	(20)	7	2.1	8	2.4	5	1.5	6	1.8		
1	(25)	7	2.1	8	2.4	6	1.8	8	2.4		
1-1/4	(32)	7	2.1	10	3.0	6	2.1	8	2.4		
1-1/2	(40)	9	2.7	10	3.0	8	2.4	8	2.4		
2	(50)	10	3.0	10	3.0	8	2.4	8	2.4		
2-1/2	(65)	11	3.4	10	3.0	9	2.7	8	2.4		
3	(80)	12	3.7	10	3.0	10	3.0	8	2.4		
3-1/2	(90)	12	3.7	10	3.0	10	3.0	8	2.4		
4	(100)	12	3.7	10	3.0	10	3.0	8	2.4		
5	(125)	12	3.7	10	3.0	10	30	8	2.4		
6	(150)	12	3.7	10	3.0	10	3.0	8	2.4		
8	(200)	12	3.7	10	3.0	10	3.0	8	2.4		
10	(250)	12	3.7	10	3.0	10	3.0	8	2.4		
12	(300)	12	3.7	10	3.0	10	3.0	8	2.4		
14	(350)	12	3.7	10	3.0						
16	(400)	12	3.7	10	3.0						
18	(450)	12	3.7	10	3.0						
20	(500)	12	3.7	10	3.0						
24	(600)	12	3.7	10	3.0						
30	(750)	12	3.7	10	3.0						
Vertical Spacing		15	4.5	15	4.5	10	3.0	10	3.0	15' (4.5m)	15' (4.5m)
3/8	(10)	7	2.1	6	1.8	5	1.5	6	1.8		
1/2	(15)	7	2.1	6	1.8	5	1.5	6	1.8		
3/4	(20)	7	2.1	8	2.4	5	1.5	6	2.1		
1	(25)	7	2.1	8	2.4	6	1.8	6	2.4		
1-1/4	(32)	7	2.1	10	3.0	6	2.1	6	2.7		
1-1/2	(40)	9	2.7	10	3.0	6	2.1	6	3.0		
2	(50)	10	3.0	10	3.0	8	2.4	10	3.4		
2-1/2	(65)	11	3.4	10	3.0	9	2.7	10	4.0		
3	(80)	12	3.7	10	3.0	10	3.0	10	4.3		
3-1/2	(90)	12	3.7	10	3.0	10	3.0	10	4.6		
4	(100)	12	3.7	10	3.0	10	3.0	10	4.9		
5	(125)	12	3.7	10	3.0	10	30	10	4.9		
6	(150)	12	3.7	10	3.0	10	3.0	10	4.9		
8	(200)	12	3.7	10	3.0	10	3.0	10	4.9		
10	(250)	12	3.7	10	3.0	10	3.0	10	4.9		

12	(300)	12	3.7	10	3.0	10	3.0	10	4.9		
14	(350)	12	3.7	10	3.0						
16	(400)	12	3.7	10	3.0						
18	(450)	12	3.7	10	3.0						
20	(500)	12	3.7	10	3.0						
24	(600)	12	3.7	10	3.0						
30	(750)	12	3.7	10	3.0						
Vertical Spacing		25	7.6	Per Code		10	3.0	Per Code		15' (4.5m)	15' (4.5m)

E.

		COLUMNS <sup>(3)</sup> 1, 2, 6, 7		COLUMNS <sup>(3)</sup> 3, 4, 9, 10, 11, 12, 13	
NOMINAL PIPE OR TUBING SIZE		NOMINAL ROD DIA.		NOMINAL ROD DIA.	
in	mm	in	mm	in	mm
1/4	(6)			3/8	M10
3/8	(10)	3/8	M10	3/8	M10
1/2	(15)	3/8	M10	3/8	M10
3/4	(20)	3/8	M10	3/8	M10
1	(25)	3/8	M10	3/8	M10
1-1/4	(32)	3/8	M10	3/8	M10
1-1/2	(40)	3/8	M10	3/8	M10
2	(50)	3/8	M10	3/8	M10
2-1/2	(65)	1/2	M12	1/2	M12
3	(80)	1/2	M12	1/2	M12
3-1/2	(90)	1/2	M12	1/2	M12
4	(100)	5/8	M16	1/2	M12
5	(125)	5/8	M16	1/2	M12
6	(150)	3/4	M20	5/8	M16
8	(200)	3/4	M20	3/4	M20
10	(250)	7/8	M20	3/4	M20
12	(300)	7/8	M20	3/4	M20
14	(350)	1	M24		
16	(400)	1	M24		
18	(450)	1	M24		
20	(500)	1-1/4	M30		
24	(600)	1-1/4	M30		
30	(750)	1-1/4	M30		

**NOTE:**

- (1) For calculated loads, rod diameters may be sized in accordance with MSS SP-58, Table 3 provided Table 1 and Section 7.3 of MSS SP-58 are satisfied.
- (2) Rods may be reduced one size for double rod hangers. Minimum rod diameter shall be 3/8 in. (M10).
- (3) Columns noted refer to Table 1, maximum horizontal pipe hanger and support spacing.

**END OF SECTION 22 05 29**

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## **SECTION 22 05 33 - HEAT TRACING FOR PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes:
  - 1. Self-regulating, parallel resistance heating cables.
  - 2. Controls.
  - 3. Accessories.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
  - 2. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.
- B. Shop Drawings: For electric heating cable.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include diagrams for power, signal, and control wiring.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.
- B. Sample Warranty: For special warranty.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

#### **1.6 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Chromalox, Inc.
  - 2. Delta-Therm Corporation.
  - 3. Pyrotenax; Tyco Thermal Controls.
  - 4. Raychem; Tyco Thermal Controls.
  - 5. Thermon Americas Inc.
- B. Comply with IEEE 515.1.
- C. Heating Element: Pair of parallel No. 16 AWG, nickel-coated, stranded copper bus wires embedded in cross linked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled, non-heating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.
- D. Electrical Insulating Jacket: Flame-retardant polyolefin.
- E. Cable Cover: Stainless-steel braid and polyolefin outer jacket with ultraviolet inhibitor.
- F. Maximum Operating Temperature (Power On): 150 deg F 65 deg C.
- G. Maximum Exposure Temperature (Power Off): 185 deg F 85 deg C.
- H. 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.
- I. Capacities and Characteristics

### **2.2 ACCESSORIES**

- A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.
- B. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils 0.08 mm thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
  - 1. Width for Markers on Pipes with OD, Including Insulation, and Less Than 6 Inches 150 mm: 3/4 inch 19 mm minimum.
  - 2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches 150 mm or Larger: 1-1/2 inches 38 mm minimum.



## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
  - 1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install electric heating cable across expansion, construction, and control joints according to manufacturer's written instructions; use cable-protection conduit and slack cable to allow movement without damage to cable.
- B. Electric Heating-Cable Installation for Freeze Protection for Piping
  - 1. Install electric heating cables after piping has been tested and before insulation is installed.
  - 2. Install electric heating cables according to IEEE 515.1.
  - 3. Install insulation over piping with electric cables according to Division 22.
  - 4. Install warning tape on piping insulation where piping is equipped with electric heating cables.
- C. Set field-adjustable switches and circuit-breaker trip ranges.

### **3.3 CONNECTIONS**

- A. Ground equipment according to Division 26.
- B. Connect wiring according to Division 26.

### **3.4 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
  - 2. Test cables for electrical continuity and insulation integrity before energizing.
  - 3. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.
- B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounted cables.
- C. Cables will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

### **3.5 PROTECTION**

- A. Protect installed heating cables, including non-heating leads, from damage during construction.
- B. Remove and replace damaged heat-tracing cables.

**END OF SECTION 22 05 33**

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## **SECTION 22 05 53 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Valve tags.
  - 5. Warning tags.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

### **PART 2 - PRODUCTS**

#### **2.1 EQUIPMENT LABELS**

- A. Metal Labels for Equipment:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Brady Corporation.
    - b. Marking Services, Inc.
    - c. Seton Identification Products.
  - 2. Material and Thickness: Brass, 0.032-inch stainless steel, 0.025-inch aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 3. Letter Color: Black.
  - 4. Background Color: White
  - 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
  7. Fasteners: Stainless-steel rivets or self-tapping screws.
  8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
  - C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## **2.2 WARNING SIGNS AND LABELS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  1. Brady Corporation.
  2. Marking Services Inc.
  3. Seton Identification Products.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: White.
- D. Background Color: Red.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

## **2.3 PIPE LABELS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  1. Brady Corporation.
  2. Marking Services Inc.
  3. Seton Identification Products.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Pretensioned Pipe Labels: Precoiled, semi-rigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.

- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: Size letters according to ASME A13.1 for piping At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

## **2.4 VALVE TAGS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Brady Corporation.
  - 2. Marking Services Inc.
  - 3. Seton Identification Products.
- B. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
  - 1. Tag Material: Brass, 0.032-inch or stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass wire-link chain or beaded chain or S-hook.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1. Valve-tag schedule shall be included in operation and maintenance data.

## **2.5 WARNING TAGS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Brady Corporation.
  - 2. Marking Services Inc.
  - 3. Seton Identification Products.
- B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
  - 1. Size: Approximately 4 by 7 inches.
  - 2. Fasteners: Reinforced grommet and wire or string.
  - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
  - 4. Color: Safety yellow background with black lettering.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### **3.2 GENERAL INSTALLATION REQUIREMENTS**

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

### **3.3 EQUIPMENT LABEL INSTALLATION**

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### **3.4 PIPE LABEL INSTALLATION**

- A. Piping Color Coding: Painting of piping is specified in Division 09.
- B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  - 1. Near each valve and control device.
  - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
  - 5. Near major equipment items and other points of origination and termination.
  - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
  - 8. Mains shall be labeled at points of entrance and exit from mechanical room, adjacent to each valve, on each riser, at each tee fitting, at points of entrance and exit from building, at least once in each room, and at intervals no longer than 20 feet.
- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.

### **3.5 PIPE IDENTIFICATION**

- A. Provide color-coded pipe identification markers on piping installed under this Section. Pipe markers shall be snap-on laminated plastic protected by clear acrylic coating. Pipe markers shall be applied after Architectural painting where such is required.
- B. Provide arrow marker with each pipe content marker to indicate direction of flow. If flow can be in either direction, use double-headed arrow marker.
- C. In general, 2 inch high legend shall be used for pipe lines 4 inch dia. and larger, and 3/4 inches high legend shall be used for pipe lines 3 inches dia. and smaller.
- D. Color banding shall meet ANSI latest and OSHA requirements.
- E. Markers shall have legends and color coding per the tables below:
- F. Markers are to be applied to all piping, regardless of under jacket colors per the following schedule:

CHART 1 Basic Plumbing Services			
SERVICE	CODE	MARKER LEGEND	LETTERING & BACKGROUND COLOR
Domestic Cold Water	CW	Potable CW	White on Green
Domestic Hot Water	HW	Potable HW	White on Green
Domestic Hot Water Return	HWR	Potable HWR	White on Green
Non-Potable Water	NPW	NPW	Black on Yellow
Trap Primer	TP	Trap Primer Supply	Black on Yellow
Gas (Natural) - low pressure	G	Gas 14 inch WC	Black on Yellow
Gas Vent	GV	Gas Vent	Black on Yellow
Indirect Waste	IW	Per Service	Black on Yellow
Rainwater	RW	Storm Drain	White on Green
Secondary Rainwater	RW	Storm Drain Overflow	White on Green
Sanitary Waste & Vent, Kitchen Waste	San	San. Waste, San. Vent, Kitchen Waste	White on Black
Garage Waste	GW	Garage Waste	White on Black
Force Main (Sanitary)	FM	FM "Per Service"	White on Black

- G. The Following Areas shall require all insulated piping to be protected along the entire pipe length with PVC Color Coded jacketed covers (Ceel-Co or Zeston plastic jacket):
1. Penthouse Mechanical Rooms
  2. Plumbing Equipment Rooms
  3. Mechanical Rooms
  4. Main Pipe Corridor without ceilings
  5. All Rainwater Leaders (horizontal) in areas without ceilings
  6. Shipping Docks
  7. Color pattern and system identification legend shall be as in the above schedule for pipe code.
  8. This plastic jacket shall include fitting covers and piping covers.
  9. Piping to be covered with this plastic jacket shall be insulated and finished as herein specified and then the plastic jacket shall be applied.
- H. Furnish and install one coat of primer and two coats of finish paint to all interior gas piping installed per this contract.
1. See Division 09 for paint types for interior piping.
  2. Painting shall begin at plumbing side of contract downstream of the utility company gas meter - see exterior painting below for piping exposed to weather.
  3. All gas piping shall be painted "Safety Yellow" per ANSI/ASME identification code 13.1.
  4. Painting shall include all gas vents from vent origin to termination.
  5. Include necessary paint finish touch-up where welding or jointing process has interfered with paint finish
  6. Install labels after paint has cured for a minimum of 5 days.
- I. Gas Piping Exposed to Weather or on Roof

1. Furnish and install OSHA Safety Yellow to exterior and roof mounted gas piping commencing at a starting point one (1) foot below roof to gas pipe termination point on roof in the following manner:
  - a. Primer: Epoxy primer/sealer applied at a spreading rate recommended by the manufacturer (2 coats)
    - 1) Moore M36-00/M37 Polyamide Epoxy Clear Sealer Finish
    - 2) PPG 97-14XX Series Pitt Guard DTR Polyamide Epoxy Clear Sealer Finish
    - 3) S-W Heavy Duty Epoxy B67W300 Series
  - b. Intermediate Coat: Epoxy applied at a spreading rate recommended by the manufacturer of 3.0 to 8.0 mils
    - 1) DuPont 25P High Solids Epoxy Mastic
    - 2) S-W Heavy Duty Epoxy B67W300 Series
    - 3) Tnemec Series 66 Hi-Build Epoxoline Polyamidoamine Epoxy
  - c. Topcoat: Semi gloss aliphatic polyurethane enamel applied at a spreading rate recommended by the manufacturer to achieve a dry film thickness of 2.0 - 4.0 mils.
    - 1) Moore M73/M75 Aliphatic Acrylic Urethane Semi Gloss
    - 2) PPG 97-8XXX Series Pitthane High Build Acrylic Aliphatic Urethane
    - 3) S-W Corothane II Low VOC Satin Finish B65W200 Series
2. All finish gas piping shall be painted "Safety Yellow" per ANSI/ASME identification code 13.1.
3. Include necessary paint finish touch-up where welding or jointing process has interfered with paint finish
4. Install labels after paint has cured for a minimum of five (5) days.
5. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces or conditions detrimental to formation of a durable paint film. Provide finish coats that are compatible with primers used.

### **3.6 VALVE-TAG INSTALLATION**

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  1. Tags, Valves, Equipment and Instruments
    - a. Upon completion of work, attach engraved laminated plastic tags to all valves, and instrumentation. Equipment shall bear a stamped stainless tag. Tags shall have black characters on white face, consecutively numbered and prefixed with letter P for general valves. Tags shall bear the number used in the P&IDs for those items so marked.
    - b. Embossed or engraved aluminum or brass tags may be substituted if desired. Tags shall be at least 1/8 inch thick.



- c. Tags shall be at least 1 inch diameter with numerals at least 3/8 inch high and attached by S hooks and chains.
  - d. Nameplates, catalog numbers and rating identifications shall be securely attached to electrical and mechanical equipment with screws or rivets. Adhesives or cements will not be permitted.
  - e. Non-potable water outlets shall be identified with permanently attached yellow color code or 4 inches high triangle tag reading, "water unsafe."
  - f. Coordinate numbering system with existing piping tags as not to duplicate numbers.
2. Valve-Tag Size and Shape:
- a. All Plumbing and Piping Services that are part of this contract 1-1/2 inches round.
3. Valve-Tag Colors:
- a. Comply with the same colors as indicated for Pipe Labels
4. Letter Colors:
- a. White.

### **3.7 WARNING-TAG INSTALLATION**

- A. Write required message on, and attach warning tags to, equipment and other items where required.

**END OF SECTION 22 05 53**

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## **SECTION 22 07 19 - PLUMBING PIPING INSULATION**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes insulating the following plumbing piping services:
  - 1. Insulation materials
  - 2. Accessory materials
  - 3. Factory applied jackets
  - 4. Tapes
  - 5. Securements

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Detail attachment and covering of heat tracing inside insulation.
  - 3. Detail insulation application at pipe expansion joints for each type of insulation.
  - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
  - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
  - 6. Detail application of field-applied jackets.
  - 7. Detail application at linkages of control devices.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.

#### **1.5 QUALITY ASSURANCE**

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
1. Supply and Drain Protective Shielding Guards: ICC A117.1.

## **1.6 COORDINATION**

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 22.
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

## **1.7 SCHEDULING**

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## **PART 2 - PRODUCTS**

### **2.1 INSULATION MATERIALS**

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Type A: Fiber Glass: Inorganic, incombustible, foamed or fiber glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. Certain-Teed.
  - b. Johns Manville.
  - c. Owens Corning.
  - d. Pittsburgh Corning Corporation.
2. Molded Fibrous Glass Pipe Insulation: Comply with ASTM C 547, Type 1, Grade A, and ASTM C 585, for sizes required and of a type suitable for installation on piping systems as required. One of the following types shall be used:
  3. For indoor systems operating at temperatures from 0°F (-18 deg. C) to +850 deg. F (454 deg. C):
    - a. Owens Corning™ Fiberglas™ Insulation with SSL II® Positive Closure System.
  4. For systems operating below ambient (32 deg. F (0°C) to +65 deg. F (18 deg. C)) temperature:
    - a. Owens Corning™ VaporWick® Pipe Insulation. (see Plumbing Pipe Insulation – VaporWick® Pipe Insulation)
  5. Block Insulation: ASTM C 552, Type I.
  6. Special-Shaped Insulation: ASTM C 552, Type III.
  7. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
  8. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Type B: Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Aeroflex USA, Inc.
    - b. Armacell LLC.
    - c. K-Flex USA.
- H. Type C: Mineral-Fiber, Preformed Pipe Insulation:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. Knauf Insulation.
    - c. Manson Insulation Inc.
    - d. Owens Corning.
  2. Perpendicular Oriented Mineral Fiber Insulation: ASTM C1393, Type IIIB, Category 2:
    - a. For piping equal to or larger than 10 in (250 mm) diameter operating at temperatures up to +850 deg. F (454 deg. C):

- b. Owens Corning™ Fiberglas™ FLEXWRAP® Insulation.
  - 3. Perpendicular Oriented Mineral Fiber Insulation: ASTM C1393, Type II, Category 1:
    - a. For piping equal to or larger than 10 in (250 mm) diameter operating at temperatures up to +650 deg. F (343 deg. C):
    - b. Owens Corning™ Fiberglas™ Pipe and Tank Insulation.
  - 4. Type I, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- I. Type G: Protective Shielding Pipe Covers,:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Engineered Brass Company.
    - b. Insul-Tect Products Co.
    - c. McGuire Manufacturing.
    - d. Plumberex Specialty Products, Inc.
    - e. Truebro.
    - f. Zurn Industries, LLC.
  - 2. Description: Manufactured plastic wraps for covering plumbing fixture hot-water supply hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

## 2.2 ACCESSORY MATERIALS

- A. Accessories: Provide accessories per insulating system manufacturer's recommendations, including the following:
  - 1. Closure Materials: Butt strips, bands, wires, staples, mastics, adhesives, and pressure-sensitive tapes.
    - a. Mold resistant mastics are recommended for chilled water applications.
  - 2. Field-Applied Jacketing Materials: Sheet metal, plastic, canvas, fiberglass cloth, insulating cement, PVC fitting covers.
  - 3. Support Materials: Hanger straps, hanger rods, saddles, support rings, and high density inserts.
- B. Adhesives for Indoor Applications: VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.3 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C 1136, Type II.

B. Jacket Types

TYPE	STYLE	MATERIALS
Type 1:	All Service Jacket	Vapor Barrier Jackets: Kraft reinforced foil vapor barrier with self-sealing adhesive joints. Jacket shall be heavy duty fire retardant material with glass fiber reinforcing and self-sealing lap. Jacket will be factory applied to the insulation. Jacket shall have neat, white Kraft finish or white vinyl suitable for painting, with bead puncture resistance of 50 units minimum. Vapor barrier shall be .001 inch aluminum foil adhered to the inner surface of the jacket. Permeance shall not exceed 0.02 perms. Jacket shall be Owens-Corning Fiberglass "ASJ-SSL" or Manville flamesafe "AP-T".
Type 2:	PVC Jackets:	Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket One piece, pre-molded type equal to Johns Manville Zeston 2000/300 Series PVC 20 or 30 mil jacketing and PVC fitting covers. All jackets shall follow manufacturers to comply with temperature of service piping. Jackets shall meet USDA compliance standard for all food handling
Type 3:	Color Coded PVC Jacket	Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket Same as type 2 above but color coded generally in rooms without ceilings. Color Jacket to be applied to all pipe, fittings and valves in the specified area in the schedule table below. See section 22 05 53 Identification for specific colors, these colors are to be contiguous on the piping system in the areas scheduled.
Type 4:	Aluminum Jacket:	Aluminum roll stock ready for shop or field cutting. Comply with ASTM B 209/M 3003 alloy, H-14 temper. 0.016 inch thick smooth aluminum jacket with longitudinal ZEE style closures. Jacket shall be secured at both joints with 2 inch wide aluminum straps centered over butt joint of jacket. Provide 1/2 inch wide aluminum bands on 12 inch centers. Fitting covers shall be manufactured for purpose intended and shall be of same material. Acceptable for outdoor installation.
Type 7	Protective Shielding Piping Enclosures for barrier free trap and water piping under fixture	<u>Manufacturers:</u> Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following: <u>Truebro.</u> <u>Zurn Industries, LLC.</u> Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements. Furnish protective shielding to all Emergency Eyewash units where water waste and trap are exposed and are exclusively selected for Barrier Free Use.

2.4 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. Avery Dennison Corporation, Specialty Tapes Division.
  - b. Compac Corporation.
  - c. Ideal Tape Co., Inc., an American Biltrite Company.
  - d. Knauf Insulation.
  - e. Venture Tape.
- 2. Width: 3 inches (75 mm).
  - 3. Thickness: 11.5 mils (0.29 mm).
  - 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
  - 5. Elongation: 2 percent.
  - 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
  - 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Compac Corporation.
    - b. Ideal Tape Co., Inc., an American Biltrite Company.
    - c. Venture Tape.
  - 2. Width: 2 inches (50 mm).
  - 3. Thickness: 6 mils (0.15 mm).
  - 4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
  - 5. Elongation: 500 percent.
  - 6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

## 2.5 SECUREMENTS

- A. Bands:
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. ITW Insulation Systems; Illinois Tool Works, Inc.
    - b. RPR Products, Inc.
  - 2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) 3/4 inch (19 mm) wide with wing seal or closed seal.
  - 3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, (13 mm)3/4 inch (19 mm) wide with wing seal or closed seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.
- C. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. C & F Wire.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  1. Verify that systems to be insulated have been tested and are free of defects.
  2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that applies to insulation.
- C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use de-mineralized water.

#### **3.3 GENERAL INSTALLATION REQUIREMENTS**

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.



- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
1. Install insulation continuously through hangers and around anchor attachments.
  2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
  2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) OC.
  3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) OC.
    - a. For below-ambient services, apply vapor-barrier mastic over staples.
  4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
  2. Testing agency labels and stamps.
  3. Nameplates and data plates.
  4. Cleanouts.

### **3.4 PENETRATIONS**

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
  4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
  4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Division 07 for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
  2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07.

### **3.5 GENERAL PIPE INSULATION INSTALLATION**

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever

- is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### **3.6 INSTALLATION OF FIBER-GLASS INSULATION**

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches (150 mm) OC.

4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of FIBER-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of fiber-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of FIBER-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

### 3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### **3.8 INSTALLATION OF MINERAL-FIBER INSULATION**

#### **A. Insulation Installation on Straight Pipes and Tubes:**

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) OC.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

#### **B. Insulation Installation on Pipe Flanges:**

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

#### **C. Insulation Installation on Pipe Fittings and Elbows:**

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

#### **D. Insulation Installation on Valves and Pipe Specialties:**

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

### **3.9 FIELD-APPLIED JACKET INSTALLATION**

#### **A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.**

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.

2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
  3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.
  4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal with manufacturers recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) OC. and at end joints.

### **3.10 FINISHES**

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material:
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

### **3.11 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Tests and Inspections:
1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### 3.12 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Underground piping.
  2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.13 PIPING INSULATION SCHEDULE

Piping System	Insulation Type	Thickness Inch	Jacket	Notes
Water Service Cold, Up To Meter - Water Supply	A C	1 1	Type 2	
All Cold Water Supply	A C	1/2 3/4"	Type 1	Note 4 Note 5
All Hot Water Supply And Return less than 1-1/2 inches	A C	1 1	Type 1	Note 4 Note 5
All Hot Water Supply And Return greater than 1-1/4 inches	A C	1-1/2 1-1/2	Type 1	Note 4 Note 5
All Insulated Piping In Mechanical Rooms, Corridors Without Ceilings,	Per This Table	Per This Table	Type 3	Note 5
Roof Drains And Horizontal Rainwater, Including Overflow Drainage System	A C	1/2 1	Type 1	Note 3 Include Drain Bodies Note 5
Floor Drains, Traps, And Sanitary Drain Piping Within 10 Feet (3 M) Of Drain Receiving Condensate And Equipment Drain Water Below 60 deg F (16 deg C)	A B C	1-1/2 3/4 1/2	Type 1	Note 3
Hot Service Drains And Vents	A C	1-1/2 1	Type 1	Note 3 Note 5
Piping Exposed To Freezing (Water)	A C	2	Type 5	Note 2
Piping Exposed To Freezing (Sanitary)	A C	2	Type 5	Note 2
Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, And Stops For Plumbing Fixtures For People With Disabilities	G	1/2	Type 7	Package System Only Includes EW&S Where Designated For Barrier Free Use.

#### Supplemental Notes

- Note 1: Two layers of 1 inch with staggered joints. Provide stainless steel 1/2 inch steel bands, 12 inches on center, apply 1 foot hexagonal mesh over insulation and 1/2 inch thick coat of insulating cement troweled smooth. Apply glass cloth jacket and size with one brush coat of lagging adhesive.
- Note 2: Contractor shall furnish and install heat trace tape, prior to insulation installation. Raychem self-regulating Winter Guard Plus 8 watts per foot with failure alarm
- Note 3: Insulation shall include drain sump body and all horizontal piping to, and including the elbow down to vertical.

Piping System	Insulation Type	Thickness Inch	Jacket	Notes
<p>Note 4: Unless noted otherwise this section pertains to ALL piping in a specified system, including in-chase or in-shaft piping.</p> <p>Note 5: The Following Areas shall require all insulated piping to be protected along the entire pipe length with PVC Color Coded jacketed covers (Ceel-Co or Zeston plastic jacket), this applies to exposed piping. If the piping is located above a ceiling, then use white PVC jackets and labels</p> <ul style="list-style-type: none"> <li>• Plumbing Equipment Rooms</li> <li>• Mechanical Rooms</li> <li>• Main Pipe Corridor without ceilings</li> <li>• All Rainwater Leaders (horizontal) in areas without ceilings</li> <li>• Other areas without hung ceilings</li> <li>• Color pattern and system identification legend shall be as in the above schedule for pipe code.</li> <li>• This plastic jacket shall include fitting covers and piping covers.</li> <li>• Piping to be covered with this plastic jacket shall be insulated and finished as herein specified and then the plastic jacket shall be applied.</li> </ul>				

**END OF SECTION 22 07 19**

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## **SECTION 22 11 10 - COMMON PLUMBING PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Piping materials.
  - 2. Under-building-slab and aboveground pipes, tubes, and fittings inside buildings.
  - 3. Dielectric fittings.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For transition fittings and dielectric fittings.
- B. All Pipe, Fittings, Valves and Sundries contained in this specification section. All piping systems shall be submitted as a single piping submittal package with labels tagged consistent with the pipe index found in Part 2 of this spec.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. All Product shop drawings and submittal sheets for all pipe, fittings, valves, equipment, appurtenances, and systems included in this section
- B. System purging and disinfecting activities report.
- C. Field quality-control reports.

### **PART 2 - PRODUCTS**

#### **2.1 PIPING MATERIALS**

- A. Comply with requirements in "Piping Schedule Index and Pipe Tables." Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

- B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

**2.2 UNDER-BUILDING-SLAB AND ABOVEGROUND PIPES, TUBES, AND FITTINGS INSIDE BUILDINGS**

<b>PIPE CLASS A05 EXTERIOR UNDERGROUND WATER</b>		
<b>Item</b>	<b>3 inches and smaller</b>	<b>4 inches and larger</b>
PIPE	Type "K" copper water tube conforming to ASTM B88 annealed.	Ductile Iron AWWA C151 class 52. Cement lining ANSI A21.4 and AWWA C104. The outside coating shall be a bituminous coating of 1mil minimum thickness. The pipe shall be clearly marked with the letters "Ductile" or "DI" and shall indicate weight, class and casting period.
FITTINGS	ANSI/ASME B16.22 wrought copper and bronze pressure fittings.	Ductile Iron 250 psi rating conforming to AWWA C-110, cement lining AWWA C-104. The fittings shall be clearly marked with the letters "Ductile" or "DI" and shall have an outside bituminous coating of one mil.
JOINTS	ANSI/AWS A5.8 BcuP silver braze.	<p>Push on joints shall conform to a single rubber gasket joint per ANSI A21.11 and AWWA C111. Flange joints and pipe flanges shall conform to ANSI B16.1. Flanged joints are to be fitted such that the contact faces bear uniformly on the gasket and are made with uniform bolt stress.</p> <p>Note: Entrance piping to the building shall be equipped with flanged joints terminated above grade. Underslab piping and routed pipe to the exterior service shall be restrained with Meg-a Lug series of joint restraint at every fitting.</p>
<b>VALVES: Valves shall be UL listed and FM approved</b>		
GATE	Bronze body flare or corporation stop ends. The valve shall be fitted with a curb box. Curb shut-off standards are to comply with the local municipal water department.	<p>Iron body flanged OS&amp;Y 175 psi, unless noted otherwise bronze-mounted with non-rising stems. Valves shall be of materials and weights required by NFPA standards. Valves shall be normally-open and shall accommodate tamper switches not furnished under Electrical Section.</p> <p>Valves shall be fitted with indicator posts. Valve and indicator post assemblies shall be FM approved and UL listed.</p> <p>Nibco M-609, Watts 408-RW or Mueller A-2360 with EJP Model E-6 flush valve box or Nibco NIP-1AJ indicator post.</p>
FLANGES		Flanges shall be plain faced, CI 250 and shall match the piping system and fittings on which they are installed.

PIPE CLASS A05	EXTERIOR UNDERGROUND WATER	
Item	3 inches and smaller	4 inches and larger
GASKETS/BOLTS		<p>Gaskets shall be AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.</p> <p>Bolts and nuts shall conform to ANSI B18.2.1 and B18.2.2 respectively.</p> <p>Full-face or ring type unless otherwise indicated.</p>
PROTECTION		Encase pipe and fittings in loose 8 mil polypropylene sleeve conforming to ANSI A21.5. Provide magnetic trace tape 12 inches above pipe for future connection.

**NOTES:**

1. Submit to the Water Authority having jurisdiction and secure all local permits and approvals for the underground water piping system prior to submitting working drawings to the engineer. The working drawing submittal to the engineer shall include an approval notification from the local water authority.
2. Receiving, Storage, and Handling - Pipe shall be unloaded using slings, hooks, pipe tongs or skids. Care should be taken to avoid injury to coating or lining. Store lubricant for rubber joints in a sanitary condition as an aid in disinfection of the main. Rubber gaskets shall be used on a first in, first out basis and stored in a cool dark location.
3. Thrust restraint shall be installed at all changes in direction, tees, dead ends and where changes in pipe size occur by the use of concrete thrust blocks, restrained joints and tie rods.
4. Below grade piping shall terminate 6 inches above finish floor of building with a blind flange with a 1 inches tapped female thread. Attach a 1 inches x 6 inches schedule 40 bronze pipe nipple and a 1 inches hose end ball valve. Provide a Watts 009 1 inch backflow preventer and two 3/4 inch hose end outlets for construction water.

PIPE CLASS A10	1/2 inch to 2 inches	2-1/2 inches and Larger
<p>All pipe, fittings, and valves used in this distribution system and installed after January 4, 2014 must comply with the new Federal Mandate known as the "Reduction of Lead in Drinking Water Act-2014". Therefore, after the enactment date of 1/4/14, all products installed must comply. Any product pipe, fittings or valve installed after the enactment date that does not comply, shall be removed and changed by this contractor at his/her own expense to comply with the Federal Law</p>		
PIPE	Seamless copper water tube, drawn temper, Type L. ASTM B-88. See Note 1.	Seamless copper water tube, drawn temper, Type L. ASTM B-88. See Notes 2 and 5.
FITTINGS	Wrought copper, solder-joint. ASME B16.22	Ductile iron coupling with copper alkyd enamel paint coating, ASTM A-536. Grade "EHP" EPDM elastomer gasket rated -30F to 250F, ASTM D-2000. Equal to Victaulic Style 607 coupling. ASTM B-75 or ASTM B-152 copper alloy fittings or ASTM B-584 grooved end cast bronze fittings per UNS C89836 or C92200.
JOINTS	ASTM solder filler material shall be lead free to comply with the federal mandate of 2014. ASTM B-813 liquid or paste flux. Soldering procedures shall comply with ASTM B-828.	Rolled groove prepared and assembled in accordance with manufacturer instructions.
MECHANICAL JOINTS	Cast copper alloy unions, hexagonal stock with ball-and-socket joint, solder joint ends. ASME B16.18.	ANSI Class 150 flange adapter equal to Victaulic Style 641 for connections to flanged equipment. ANSI B16.1 dimensions.
BRANCH CONNECTIONS		Victaulic Mechanical T Style 622
<p><b>VALVES</b>  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: Apollo, Watts, Milwaukee, Nibco, or Conbraco.</p>		
Gate Valve	Use ball valve.	Outside stem and yoke resilient wedge flanged gate valve, lead free model, Watts Series 408-OSYRW. This valve intended for main shutoff in compliance with local water department regulations.
Ball Valve	All bronze lead free, 2-piece, full port, PTFE seats, solder end connections. 600 psig WOG. Apollo 77BLF-100, Watts Milwaukee, <u>Watts LF-B6081</u> .	Class 125, cast iron body, FDA epoxy coated. Full port, flanged ends, stainless steel ball and stem. ANSI B16.1 flange dimensions. <u>Watts G-4000-FDA</u> series, Apollo IBV.

PIPE CLASS A10	1/2 inch to 2 inches	2-1/2 inches and Larger
Butterfly Valve	Equal to <u>Victaulic Series 608 butterfly valves</u> bubble-tight shut-off to 300 psi with the following features: <ul style="list-style-type: none"> <li>• Lead free design</li> <li>• Join to the piping system with Style 607 couplings.</li> <li>• Double-seal disc design with a resilient elastomeric coating bonded to the ductile iron disc core. Grade CHP fluoro-elastomer rated -30 deg F to 250 deg F.</li> <li>• Double-seal disc design with a resilient elastomeric coating bonded to the ductile iron disc core.</li> <li>• The disc actuated by a manual lever, gear.</li> <li>• Dead end service provided to full working pressure in both directions.</li> <li>• Sealing and positive shut-off are accomplished by a double ring seal.</li> </ul>	
Check Valve	Lead Free Bronze body and clapper, solder ends, 200 WOG. <u>Apollo 163 SLF Series, Watts LFWCV-CVS series, Milwaukee, Stockham.</u>	Iron body, bronze mounted, flanged ends, 200 WOG. <u>Apollo 910F Series, Milwaukee F-2974-M, Stockham G-931.</u>
Balancing Valve With Flow Meter	Application: Inlet of all Tempering Valves, Inlet of Building Hot Water Re-circulating pumps. Integral automatic balancing circuit valve with integral flow meter display. Sizes range from 1/2 inch to 2 inches selected per flow rate. Equal to <u>Caleffi Corporation model 132 Quick Setter low lead balancing valve with flow meter.</u>	
Balancing Valve With Temperature Gauge	Application: at all circuit returns to the hot water circulated return main. Integral automatic balancing circuit valve with integral cartridge flow rate. Sizes range from 1/2 inch to 2 inches selected per flow rate. Equal to <u>Red &amp; White Valve Corporation series 9500 Lead Free.</u> Provide separate downstream temperature gauge in conformance with spec section 22 05 19 "Meters and Gauges"	
Drain Valve	All bronze, 2 piece, RPTFE seats, thread x solder end connections. 600 Psig WOG. <u>Apollo 70LF-100-HC, Milwaukee, Watts.</u> Hose thread adapter with cap and chain. Provide hose end vacuum breaker to be lead free.	
Strainers	Bronze body, threaded or solder ends to suit, stainless steel screen, 400 pound WOG. <u>Apollo 59LF series</u>	
Pressure Reducing Valve	Control Valve, <u>Apollo A127LF, Pilot Operated. Watts LF-M115, CLA-VAL.</u> Valves to be lead free.	
Solenoid Valve	2-way solenoid valves are internally piloted with assisted lift valves featuring lead-free Brass, stainless steel construction and FKM seal material. Coordinate voltage with electrician. <u>Omega Series SV-6100, Granzow Series W lead free</u>	
NOTES:		
<ol style="list-style-type: none"> <li>1. Below grade water piping 3 inches and smaller shall be Type K copper with brazed joints, BcuP filler alloy. ANSI/AWS A5.8. Procedures shall be per ANSI/AWS B2.2.</li> <li>2. Contact between dissimilar metals shall be made with di-electric couplings or di-electric flanges. Contact between ferrous and stud bolts and bronze flanges shall be electrically insulated with non-metallic washers.</li> <li>3. Provide mechanical joint connections to all equipment such as water heaters, pumps, compressors, etc.</li> <li>4. Above grade water piping 8 inches and larger shall be Schedule 40 galvanized steel piping with galvanized fittings and grooved joints.</li> <li>5. Valves used for throttling of flow shall be butterfly type with memory stop. Ball valves shall not be acceptable on hot water return piping</li> <li>6. Valves shall be provided with Buna-N, TFE, or EPDM seats suitable for the service intended.</li> <li>7. The pressure classifications for valves specified herein are working steam or water, oil, gas (WOG) pressure ratings.</li> <li>8. Lever handles on all valves shall be color coded in conformance with ANSI Standard A-13.1</li> <li>9. Shut-off valves on the incoming water service and on the discharge of the water meter shall be a gate valve or other full-way valve</li> <li>10. Ball valves used to isolate emergency equipment shall be equipped with a "latch lock lever" #(-27) and be pad locked in the open position.</li> <li>11. Balancing valves for the domestic hot water system shall be lead free bronze body or a metal copper-</li> </ol>		

PIPE CLASS A10	1/2 inch to 2 inches	2-1/2 inches and Larger
<p>alloy construction, with differential read out ports, concealed memory stop with digital hand wheel, and drain port. Installation shall be in accordance with manufacturers' recommendations.</p> <p>12. Grooved joint couplings shall incorporate an angled-pattern bolt pad design to provide confirmation of joint integrity upon visual metal-to-metal bolt pad contact with slight offset and no torque requirement. Tongue and recess designs may only be used if a torque wrench is utilized (IAW published installation instructions) and each coupling is either tagged or marked with indelible ink to indicate the actual torque value attained.</p> <p>13. A factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. Contractor shall remove and replace any improperly installed products. Gaskets used on potable water systems shall be UL classified in accordance with ANSI/NSF-61 for both hot (180 deg F) and cold (86 deg F). Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.</p>		

<b>PIPE CLASS A11</b>	<b>Gas Piping</b>	
Item	2 inches and Smaller	2-1/2 inches and Larger
PIPE	Schedule 40 Carbon Steel ASTM A53 Grade B, A106 Grade A, or ASTM A120.	Schedule 40 Carbon Steel ASTM A53 Grade B, ASTM A106 Grade A, or ASTM A120.
FITTINGS	Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern	Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding
UNIONS	Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends	Use Flanges.
FLANGES	<p>Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:  Material Group: 1.1.  End Connections: Threaded or butt welding to match pipe.  Lapped Face: Not permitted underground.  Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum O-rings, and spiral-wound metal gaskets.  Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground</p>	
VALVES	<p>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:  Watts Regulator, Apollo, Serd Audco, Resun, Nordstrom, AY McDonald  Note: All valves used for gas shall be approved for use by the State Fuel Gas Code and/or the State Plumbing Board.</p>	
Plug/Gas Cock Valves	Bronze body and plug manually operated low pressure (2 psig or less) natural or propane gas valve for use indoors at ambient temperatures of 32 to 125 degrees Fahrenheit Basis of Design: A.Y. McDonald 10558	Iron Body, Greasable and Lubricated Tapered Plug, rectangular port, regular opening, Flanged End, WOG, 125 psi SWP Valve shall be equal to R&M Energy Systems Inc. Resun Model #1431 200 psi.
Solenoid Valves	<p>Intrinsically safe specifications completely encapsulated within the enclosure using epoxy material. Valve shall be furnished with NEMA 4x conduit hub and shall be explosion proof design. Operate at 120 VAC with an intrinsic safety barrier.  Basis of Design: ASCO gas shutoff valve series EF-8210 brass body valve.  Note: for substituted valves that require pneumatics, furnish 40 micron filtered 1/2" compressed air for valve operation</p>	
Ball Valves	Bottom loaded pressure stem valve rated at 600 psi WOG. Basis of Design: Watts B-6000-UL-MassApollo 70-100-07 series, Watts FBV-3C	Ball valves shall be of the floating-ball design providing bi-directional, tight shutoff in accordance with MSS SP-72. The valves shall be rated at 150# WSP/300# WOG. Bodies shall be ductile iron per ASTM A536, With ANSI Class 150 raised-face flanges. The interior and exterior of the body shall be UL certified polyester powder coated to meet NSF/ANSI 61 and NSF/ANSI 372. The ball shall be PFA infused stainless steel, with a stainless steel blowout-proof stem. The seats and body seals shall be PTFE. The stem seal shall be PTFE, externally adjustable chevron type. Valves shall be equipped with locking handles as standard. Valves shall be equipped with 2" manual gear

<b>PIPE CLASS A11</b>	<b>Gas Piping</b>	
Item	2 inches and Smaller	2-1/2 inches and Larger
		operators. Basis of Design: American Valve, Inc Series 4000D
Check Valves	All available sizes: 150# Class, bronze swing check valve. Aluminum disc, screwed cap, threaded or flanged ends, lifting lug for 3 – 8 inch valves. Basis of Design: Eclipse Inc. Series 1000.	
Fire Safety Gas Automatic Shutoff Valve	<p>Inner-Tite Corporation fire valve, Class 125 cast iron body swing check valve for installation in the natural gas service line of large volume gas users. The fire valve shall shut off the flow of gas in the event of a fire.</p> <p>In the event of a fire, the exposed heat collecting fins on the fuse plug transmit the elevated temperature to the fusible metal alloy within the plug. The solder is engineered to melt at a temperature of 165 deg F. When this occurs, it releases the Shut-off Cover which then closes and stops the flow of gas.</p> <p>Conforms to MSS-SP-71, Type 1. Conforms to ANSI B16.10 and B16.1.</p> <p>Note: The plumbing contractor shall seek a product approval variance for the use of this valve for this project only. (Massachusetts Projects Only)</p> <p>Basis of Design: Inner Tite Flange Fire Valve</p>	
Main Gas Service Regulators	<p>Coordinate with the Utility for gas service regulators. The service regulator is to be furnished and installed by contractor</p> <p>Basis of Design: Piero Fiorentini Norval or Dival series regulator selection program link</p>	
Line Pressure Regulator – (5 psig to low pressure)	<p>Comply with ANSI Z21.80.</p> <p>Body and Diaphragm Case: Ductile iron or die-cast aluminum.</p> <p>Springs: Zinc-plated steel; interchangeable.</p> <p>Diaphragm Plate: Zinc-plated steel.</p> <p>Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.</p> <p>Orifice: Aluminum; interchangeable.</p> <p>Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.</p> <p>Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.</p> <p>Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.</p> <p>Overpressure Protection Device: Factory mounted on pressure regulator.</p> <p>Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.</p> <p>Over Pressure Device: 4 port dual model device</p> <p>Maximum Inlet Pressure: 5 psig, (34.5kPa)</p> <p>Basis of Design: Pietro Fiorentini Governor Overprotection Device (ODP) Operator/Monitor model</p> <p>Maximum inlet pressure 10 psig (69 kPa) Pietro Fiorentini Governor Overprotection Device (ODP) model two stage pressure cut model</p>	
Line Pressure Regulator – (2 psig to low pressure)	<p>Comply with ANSI Z21.80.</p> <p>Body and Diaphragm Case: Ductile iron or die-cast aluminum.</p> <p>Springs: Zinc-plated steel; interchangeable.</p> <p>Diaphragm Plate: Zinc-plated steel.</p> <p>Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.</p> <p>Orifice: Aluminum; interchangeable.</p> <p>Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.</p> <p>Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.</p> <p>Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.</p>	



<b>PIPE CLASS A11</b>	<b>Gas Piping</b>	
Item	2 inches and Smaller	2-1/2 inches and Larger
	Overpressure Protection Device: Factory mounted on pressure regulator. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping. Maximum Inlet Pressure: 2 psig (13.8 kPa) Basis of Design: Pietro Fiorentini Governor model	
<b>SPECIALTY ISOLATION AND CONTROL COMPONENTS</b>	Note: All valves used for gas shall be approved for use by the State Fuel Gas Code and/or the State Plumbing Board.	
NOTES:		
<ol style="list-style-type: none"> <li>1. Provide a branch ball valve and positive silent check valve on each pipe branch within each laboratory on the gas pipe floor sub-main downstream of the Lab module cabinet gas shutoff valve</li> <li>2. Provide two wrenches for each gas cock size.</li> <li>3. The Contractor, at his option, may weld piping down to 1-1/4 if permitted by local codes.</li> <li>4. All welders for gas piping must be certified per the requirements of Division 22.</li> <li>5. Where multiple gas regulators are installed, regulators shall be marked with a metal tag designating the building or areas being supplied. For all underground installation, Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.</li> </ol>		

<b>PIPE CLASS A17 GALVANIZED STEEL PIPING</b>		
Item	2 inches and Smaller	3 inches and Larger
PIPE	Schedule 40 Galvanized Steel. ASTM A53 Grade B, A106 Grade A or A120.	Schedule 40 Galvanized Steel. ASTM A53 Grade B, ASTM A106 Grade A or ASTM A120.
FITTINGS	Screwed malleable iron 125 PSI galvanized.	Grooved ductile iron 150 PSI galvanized.
UNIONS	Screwed 150# malleable iron A105 Grade II, galvanized.	Coupling shall act as union.
FLANGES	150# raised face, screwed, A105 galvanized.	Flange adapter Victaulic Style 741.
GASKETS	1/16 inch red rubber, wire inserted. 150 raised face and 125 flat face gasket.	Selected for intended service.
GATE VALVES	Use Ball Valve	Use Butterfly Valve <u>Victaulic series 300</u>
BALL VALVE	2-piece all bronze, full port, PTFE seats thread end, 4 bolt 600 PSI CW working press. Milwaukee Ba-300, <u>Apollo 77F</u> , <u>Watts B-6080</u> . <u>Victaulic series 721</u>	150# class, carbon steel body, stainless steel ball and stem, Teflon seat and seal, flanged. <u>Jamesbury 5150-31-22</u> . <u>Apollo CS Flanged Series</u> . Or use Butterfly Valve for sizes 3" and greater
BUTTERFLY VALVE	Use ball valve	150# rated, full lug type wafer ductile iron body, alum/bronze disc, stainless steel stem, EDPM or NPR Seat. <u>DeZurik series BOS-US</u> , <u>Victaulic Series 761 with ductile iron body</u> , <u>Crane Centerline series</u>
DRAIN VALVE	600 WOG bronze ball valve, NPT x 3/4 inch hose with gasketed cap and chain. Milwaukee BA-100-4, Apollo 77F with	

PIPE CLASS A17 GALVANIZED STEEL PIPING		
	3/4" hose connection and cap.	
CHECK VALVES	For water - Horizontal swing, composition disc, all bronze, threaded ends, 200 PSI Wp. Basis of Design: Milwaukee 509, Jenkins 352c, Stockham B319. For compressed air – <u>Apollo 61-700 series</u> , <u>Victaulic series 716H</u>	Flanged swing check, class 125 for decelerated disc closure and Installation at no more than 45 degrees from horizontal, flanged end, 200 PSI WP. Basis of Design: <u>Jenkins 477-L</u> , <u>Stockham G931-L&amp;W.</u> , <u>Victaulic series 716</u>
<p>NOTES:</p> <p>1. When steel comes in contact with dissimilar material, provide di-electric couplings or dielectric flanges. Contact between ferrous stud bolts and bronze flanges shall be electrically insulated with non-metallic washers. Provide union connections to all pneumatically operated equipment.</p>		

PIPE CLASS D10		CAST IRON PIPING	
Item	Above Grade	Below Grade	
PIPE	2 inches and larger: Hubless Cast Iron Soil Pipe, Service Weight. ASTM-A-888, CISPI 301. Type L Copper Tubing. ASTM B8872. See Note 1.	2 inches And Larger: Hub And Spigot Cast Iron Soil Pipe, Extra Heavy. ASTM A-74 or Service Weight if Code Approved. Piping shall be Asphalt or Coal Tar Pitch Coated.	
FITTINGS	2 inches and larger Hubless Cast Iron Fittings, Service Weight. ASTM-A-888, CISPI 801. or Wrought Copper DWV Fittings. See Note 1	2 inches and Larger: Hub and Spigot Cast Iron Fittings, Extra Heavy or service weight ASTM A-74. Asphalt or Coal Tar Pitch Coated. DWV Pattern.	
CAST IRON SOVENT FITTINGS	For sanitary waste systems only, Cast Iron Sovent system and fittings are acceptable. <u>Cast Iron Sovent DWV system</u> installed in accordance with approved construction plans and specifications in compliance with criteria set forth by "Cast Iron Sovent Design Manual #802" as published by Conine Manufacturing Co., Inc. The Cast Iron Sovent Aerator and De-aerator fittings shall be in compliance with ASME standard B16.45-1998.		
JOINTS	Hubless Cast Iron: Heavy Duty Stainless Steel Band Coupling with Neoprene Gasket. Bank Torque of 80 Foot-Pounds. 15 PSIG Pressure Rating. Husky SD 4000 or Clamp-All Hi-Torq 80. See Note 2. Copper: 95/5 Solder.	Neoprene Compression Gaskets Conforming to ASTM C-564.	
BACKWATER VALVE – PIT STYLE	Pit Style Backwater Valve: Duco Cast Iron Gravity with Bronze Backwater Valve and CI Secured Gate. Provide flashing clamp. Polished Bronze Face. <u>J.R. Smith Co. 7000,, Zurn, Josam, Watts.</u>		
BACKWATER VALVE – IN LINE	Cast Iron Gravity Flow Type, Bronze Mounted, Hub End. Exterior shall be Mastic Coated, Bolted or Extended Cover in Accordance with Installation Parameters. <u>J.R. Smith Co. 7012 - 7022, Josam 67500, Zurn Industries Z-1095, Watts, BV-200.</u>		
BACKWATER – MANUAL SHUTOFF GATE	Duco Cast Iron Gravity Flow Type, Bronze Mounted with removable wheel handle. <u>J.R. Smith Co. 7150, Josam, Zurn Industries, Watts.</u>		
NOTES:	<ol style="list-style-type: none"> <li>1. CISPI 310 no-hub couplings will not be accepted as equal to manufacturers listed.</li> <li>2. Copper tube and fittings shall not be used on urinal wastes.</li> </ol>		

<b>PIPE CLASS D11</b>	<b>SANITARY OR STORM FORCE MAIN PIPING</b>	
Item	3 inches and Smaller	4 inches and Larger
PIPE	Schedule 40 Galvanized Steel. ASTM A53 Grade B, A106 Grade A or A120.	Schedule 40 Galvanized Steel. ASTM A53 Grade B, A106 Grade A or A120.
FITTINGS	Screwed Cast Iron 125 PSI Galvanized.	Grooved Malleable Iron 125 PSI Galvanized.
UNIONS	Screwed 150# Malleable Iron A105 Grade li, Galvanized.	Use Flanges.
FLANGES	150# Raised Face, Screwed, A105 Galvanized.	150# Raised Face Galvanized Uniflange, ASTM A181, Grade I. 150# Flat Face for Cast Iron Valve.
GASKETS	1/16 inch Red Rubber, Wire Inserted. 150 Raised Face And 125 Flat Face Gasket.	
GATE VALVE	2-1/2 inches and Smaller: 125# Class, All Bronze, Rising Stem, Solid Disc, Solder Ends Screwed Bonnet, Solid Disc, Screw Ends Milwaukee 148, Apollo 101T, Stockham B-114.	3 inches and Larger: 125# Class, Iron Body, Os&Y Bronze Mounted, Flanged Ends. Milwaukee F-2885-M, Apollo 611F, Stockham G-623, Watts 408 OSY-RW.
CHECK VALVE	Horizontal Swing, Composition Disc, All Bronze, Threaded Ends, 200 PSI Wp. Milwaukee 509, Apollo 161T, Stockham B319.	Outside Lever And Weight Swing Check, lbbm for Installation at no more than 45 degrees from horizontal, Flanged End, 200 PSI Wp. Jenkins 477-L, Stockham G931-L&W, Apollo 910 FLW.
SUMP EJECTOR SYSTEM	Alternative option for valve arrangement at the outlet of duplex sewage ejectors and/ or sump pump systems: Victaulic Series 318 Sump Ejector. System complete with Victaulic Series 317 AWWA check valve supplied with arm and spring configuration and Victaulic series 365 plug valve with lever handle.	

## 2.3 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. A. Y. McDonald Mfg. Co.
    - b. Watts; a Watts Water Technologies company.
    - c. Wilkins.
    - d. Zurn Industries, LLC.
  - 2. Standard: ASSE 1079.
  - 3. Pressure Rating: 125 psig minimum at 180 deg F for low pressure piping and 150 psig 250 psig for high systems where the operating pressure exceeds 150 psig.
  - 4. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Watts; a Watts Water Technologies company.
    - b. Wilkins.
    - c. Zurn Industries, LLC.
  - 2. Standard: ASSE 1079.
  - 3. Factory-fabricated, bolted, companion-flange assembly.
  - 4. Pressure Rating: 125 psig minimum at 180 deg F 150 psig 175 psig 300 psig match system working pressure.
  - 5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Central Plastics Company.
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Non-conducting materials for field assembly of companion flanges.

3. Pressure Rating: 150 psig.
4. Gasket: Neoprene or phenolic.
5. Bolt Sleeves: Phenolic or polyethylene.
6. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Elster Perfection Corporation.
  - b. Grinnell Mechanical Products.
  - c. Precision Plumbing Products.
  - d. Victaulic Company.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

## PART 3 - EXECUTION

### 3.1 PIPE SCHEDULE INDEX

SERVICE	CODE	MAXIMUM SERVICE OPERATING LIMITS		PIPE CLASS	PIPE MATERIAL
		(psig)	Temp (°F)		
City or Service Water Entrance Piping	CW	100	250	A05	Type K Copper or D1CL
Domestic Cold Water	CW	100	250	A10	Type L Copper
Domestic Hot Water	HW	100	250	A10	Type L Copper
Domestic Hot Water Return	HWR	100	250	A10	Type L Copper
Non-Potable Water	NPW	100	250	A10	Type L Copper
Trap Primer	TP	100	250	A10	Type L Copper
Gas (Natural)	G	50	70	A11	C. Steel
Gas Vent	GV	50	70	A11	C. Steel
Indirect Waste (above ground)	IW	Gravity	80	A17 A10	G. Steel Copper
Sleeve for Interior Under-ground Natural Gas Piping	G-S	50	120	A17	G. Steel
Rain Leader	RW	Gravity	80	D10	Cast Iron
Sanitary Waste & Vent, Kitchen Waste	S, W or V, KW	Gravity	120	D10	Cast Iron
Indirect Waste (below ground)	IW	Gravity	80	D10	Cast Iron
Force Main (Sanitary)	FM	50	120	D11 A10	G. Steel Copper
Underground Groundwater Collection Piping	GC	0	120	D18	Schedule 40 PVC
GENERAL PIPE SPEC NOTES:					
<ol style="list-style-type: none"> <li>1. Each valve type shall be the product of a single manufacturer. Each system shall be provided with valves as required by code and shown on the drawings and shall be installed to facilitate operation, replacement and repair.</li> <li>2. Provide access panels for concealed valves behind non-removable ceilings or walls.</li> <li>3. Provide shut-off valves on supply piping to individual pieces of equipment.</li> <li>4. Provide pipe dope, Teflon tape, wax rings, neoprene gaskets and other jointing compounds as required by best standard practice and only on service as recommended by manufacturer.</li> <li>5. Apply putties and jointing compounds for plumbing fixtures and trim as recommended by manufacturers.</li> <li>6. Valves on insulated piping systems shall be equipped with extended handles to accommodate insulation thickness.</li> <li>7. All piping insulation and materials installed in return air plenums shall be plenum rated. Thermoplastic piping systems are hereby prohibited in return air plenums.</li> <li>8. Piping routed through metal stud or wood stud partitions: provide centering such that piping does not come in contact with metal studs and also protection of piping systems routed horizontally through metal stud or wood stud partitions where the piping crosses a stud. Sleeve type protection shall be used to prevent damage to the lateral piping by the use of screws/nails/fasteners. Provide pre-manufactured products equal to puncture solution, or on site sleeves.</li> </ol>					

### 3.2 EARTHWORK

- A. Comply with requirements in Division 31 for excavating, trenching, and backfilling.

### **3.3 GENERAL INSTALLATION REQUIREMENTS**

- A. Piping Installation
  - 1. Install piping approximately as shown on the drawings and as directed during installation by the General Contractor or the Architect.
  - 2. Piping shall be installed as straight and direct as possible forming right angles or parallel lines with building walls, other piping and neatly spaced.
  - 3. The horizontal runs of piping, except where concealed in partitions, shall be installed as high as possible.
- B. Piping or other apparatus shall not be installed in such a manner so as to interfere with the full swing of the doors and access to other equipment.
- C. The arrangement, positions and connections of pipes, fixtures, drains, valves, and the like, indicated on the drawings shall be followed as closely as possible, but the right is reserved by the General Contractor or the Architect to change locations and elevations to accommodate the work, without additional compensation for such change.
- D. It shall be possible to drain the water from all sections of each cold, and hot water piping system. Pitch piping back to drain valves.
- E. Screwed piping of brass or chrome plated brass shall be made up with special care to avoid marring or damaging pipe and fitting exterior and interior surfaces.
- F. Screwed pipe and copper tubing shall be reamed smooth before installation.
- G. All exposed piping in connection with fixtures and where exposed on finished walls or to view, shall be chrome plated. Where chrome plated piping is installed, cut and thread pipe so that no unplated pipe threads are visible when the work is completed.
- H. Remove and replace with new materials, any copper or brass piping (chrome plated or unplated) and valves showing visible tool marks.
- I. Vertical risers shall be firmly supported by riser clamps, properly installed to relieve all weight from the fittings.
- J. The pipe and fittings shall be manufactured in the United States of America and in accordance with the Commercial Standards, American National Standards Institute and American Society of Testing Materials.

### **3.4 GRAVITY PIPING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.



- E. Install piping free of sags and bends.
- F. Install piping to allow application of insulation.
- G. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- H. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
- I. Install steel piping according to applicable plumbing code.
- J. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- K. Be responsible for checking each pipe for alignment, centerline elevation and invert grade for underground installations.
- L. At times when 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. Pipe laid through rock excavation shall rest on a six-inch layer of well-compacted sand.
- M. The Sanitary (waste and vent), Kitchen Waste and storm drainage piping three inches and smaller in diameter shall pitch a minimum of 1/4 inch per foot, and piping four inches and larger in diameter shall pitch a minimum of 1/8 inch per foot.
- N. The vent stacks shall be connected as shown and extended through the roof a minimum of 18 inches. Waste and vent pipes shall be concealed unless otherwise noted.
- O. Every fixture shall be separately trapped and the traps must be vented unless an approved battery or wet vented system is being installed. Floor drains shall be considered as a fixture.
- P. Vents shall be connected to the discharge of each trap in the sanitary system, thence carried individually to a point above the flood level of the fixture before connecting with any other vent pipes. Pitch the branch vents back to the fixtures.
- Q. The vents passing through the roof shall be a minimum size of four inches in diameter.
- R. Cleanouts shall be provided in drainage piping at changes in directions, at foot of stacks or other required points so that all portions of the lines will be readily accessible for cleaning or rodding out.
- S. The maximum horizontal distance between cleanouts; in piping four inches in diameter and smaller shall not be more than 50 feet apart; in piping five inches in diameter and larger shall not be more than 100 feet apart.
- T. Traps on sanitary and kitchen waste piping not integral with fixtures and in accessible locations shall be provided with a brass trap screw protected by the water seal, and will be regarded as a cleanout.
- U. Test tees with brass cleanout plugs shall be provided at the foot of all vertical waste, kitchen waste and storm drainage stacks and at each floor. Wherever cleanouts on vertical lines occur concealed behind finished walls, they shall be extended to back of finished wall and a wall plate shall be provided.

### 3.5 SPECIALTY PIPING INSTALLATION

- A. Anchorage shall be provided to restrain drainage piping from axial movement.
  - 1. Bases of stacks shall be supported by the building structure, virgin or compacted earth or other material suitable to support the weight of the piping.
- B. Expansion joint fittings in drainage pipe.
  - 1. Expansion joint fittings shall be used only where necessary to provide for expansion and contraction of the pipes. The expansion joint fittings shall be of the typical material suitable for the use with the type of piping which such fittings are installed
- C. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to sanitary sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
- D. Install underground, copper, force-main tubing according to CDA's "Copper Tube Handbook."
- E. Plumbing Specialties:
  - 1. Install backwater valves in sanitary waster gravity-flow piping. Comply with requirements for backwater valves specified in Division 22.
  - 2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Division 22.
  - 3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Division 22.
- F. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- G. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22.
- H. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22.
- I. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22.

### 3.6 JOINT CONSTRUCTION (GRAVITY WASTE, VENT, KITCHEN WASTE AND STORM DRAIN SYSTEMS)

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.
- E. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.
- F. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern

### **3.7 PRESSURE PIPING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
- D. Install underground copper tube and ductile iron pipe in PE encasement according to ASTM A 674 or AWWA C105/A21.5 when soil is of corrosive nature.
- E. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Division 22 and with requirements for drain valves and strainers in this section for water piping specialties."
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. When water pressure exceeds 80 psig, install water-pressure-reducing valves downstream from shutoff valves.
- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Division 22.
- J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- M. Install piping to permit valve servicing.

- N. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- O. Install piping free of sags and bends.
- P. Install fittings for changes in direction and branch connections.
- Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- R. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Division 22.
- S. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Division 22.
- T. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Division 22.
- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22.
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22.
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22.

### **3.8 JOINT CONSTRUCTION (PRESSURE PIPING SYSTEMS)**

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  1. Apply appropriate tape or thread compound to external pipe threads.
  2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Braze Joints" chapter.
- E. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- F. Joint Construction for Grooved-End Copper Tubing: Make joints according to AWWA C606. Roll groove ends of tubes. Lubricate and install gasket over ends of tubes or tube and fitting. Install coupling housing sections over gasket with keys seated in tubing grooves. Install and tighten housing bolts.
- G. Joint Construction for Grooved-End, Ductile-Iron Piping: Make joints according to AWWA C606. Cut round-bottom grooves in ends of pipe at gasket-seat dimension required for specified (flexible

or rigid) joint. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.

- H. Joint Construction for Grooved-End Steel Piping: Make joints according to AWWA C606. Roll groove ends of pipe as specified. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections over gasket with keys seated in piping grooves. Install and tighten housing bolts.
- I. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- J. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

### **3.9 NATURAL GAS SYSTEMS**

- A. All piping shall be cut accurately to measurements obtained at the site and shall be installed without springing or forcing due to inaccurate measurements or improper hanger installation
- B. Piping shall be done by licensed gas fitter (as required by Code).
- C. Gas piping shall pitch to drain and shall have drip pockets at least 6 inches long with removable caps at low points.
- D. Gas Isolation Valves
  - 1. Provide a gas cock valve at each branch run out from main or riser serving gas outlets. This shall include all branches from the gas main and further branches from gas sub-mains. These requirements will be strictly enforced by the local plumbing inspector. This requirement shall take precedent over general arrangement drawings. Therefore the following is called for:
  - 2. Provide a gas shutoff valve at each Tee on both outlets of the Tee in a run of piping
  - 3. Provide a gas shutoff valve at each piece of equipment
  - 4. Gas valves or cocks shall not be concealed and shall be readily accessible for inspection and repair
  - 5. Every branch line from a main shall be furnished with a branch valve (no exceptions) and shall be taken off the top of main using such fittings as may be required by structural obstructions or other installation conditions. All service pipes, fittings, and valves shall be kept at sufficient distance from other work to permit not less than 1 inch between finished coverings on other service piping.
- E. Provide union connection between shut-off cock and equipment to permit disconnection of equipment
- F. Piping shall be securely fastened, separately hung and shall not support any other weight or piping. Piping dropping in concrete block walls shall be factory wrapped for corrosion protection.
- G. Welded piping shall conform to the latest requirements of the New Jersey Fuel Gas Code.
- H. All piping shall be supported independently and securely fastened to the building structure with appropriate anchors and pipe hangers. In general, all lines shall be installed above ceilings in finished spaces.
- I. All piping shall be cut true and threaded or welded. Cap all open ends of piping to prevent the entrance of debris when work on this system is complete or the work day has ended.

- J. Provide individual vents from regulators, pressure switches and reliefs on factory packaged equipment gas trains at all equipment located on this system. It is this contractor's responsibility to extend all vents to atmosphere terminal at a safe location in conjunction with the fuel gas code.
- K. Gas piping and safety devices shall meet requirements of NFPA No. 54 and shall be subject to inspection and approval of State Gas Regulatory Board.
- L. Special Note: Provide aluminum check valves on all gas pipes that enter rooms where compressed air is installed or when both compressed air and gas piping connect to the same piece of equipment. This is required in all areas where gas and air are present.
- M. All pipes shall be run parallel and graded evenly to low points. A serviceable drip leg of at least six inches in length shall be provided at each low point, at every connection to a piece of equipment, and at the base of each riser.
- N. All exterior gas piping, valves and fittings shall be protected and covered with Tapecoat H35 Gray corrosion protection tape with integral primer and adhesive. All fittings and joints shall be wrapped with similar protective tape.
- O. For gas installations of over 5,000,000 (five million) BTU/HR, submit a plan of the proposed piping system and equipment for approval to the local Gas Inspector. A letter from the servicing gas supplier indicating that the fuel supply is available shall accompany the submission. Gas utilization equipment over 12,500,000 BTU/HR, water tube boilers having outputs of 10,000 pounds of steam per hour or more, gas booster installations, cogeneration systems, and kilns, shall be submitted to and approved by the Board of State Examiners of Plumbers and Gas Fitters.
- P. Provide valved pressure gauge assemblies at each main gas service entrance, at each water heater, boiler, emergency or standby generator, incinerators, HVAC rooftop units and all other major pieces of equipment utilizing gas. Each pressure gauge assembly shall be individually valved, include a snubber and shall have a dial range that would locate the system pressure as close to the approximate mid-point on the dial range as possible. Assembly shall be similar to TRERICE Model 760B, 2-1/2 inch diameter gauge, 735-2 valve and 872-1 snubber.
- Q. Piping system shall be purged with 100 psi compressed air to remove dirt and debris.
- R. Pressure test gas piping system with air, carbon dioxide or nitrogen pressure test at not less than 10 psi gage for a period of 24 hours with no decrease in pressure. For welded piping and for piping carrying gas at pressures exceeding 14-inches of water column pressure, the test pressure shall be at least 60 psig for a period of 24 hours with no decrease in pressure. If a decrease in pressure is detected, soap or bubble test joints for leaks, repair or replace as required, and retest.
- S. Gas piping connections to all equipment shall include a gas shutoff valve, drip leg, union fitting and pressure gauge as well as a swing joint consisting of at least two 90 degree elbows at all HVAC equipment

### **3.10 GAS SERVICE, METER, VENTS AND PIPING**

- A. Gas meter and piping to meter from gas main will be provided by Gas Company. Pay charges are associated with Gas Company installation.
- B. Provide pressure reducing valve between meter and building piping, as required by Gas Company, piped and vented to outside of building.
- C. Provide full size isolation valve at the gas meter outlet.
- D. Provide an aluminum or plastic valve tag stating the gas pressure downstream of the gas meter.

### **3.11 TRANSITION FITTING INSTALLATION**

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
  - 1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
  - 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: per manufacturers recommendations

### **3.12 DIELECTRIC FITTING INSTALLATION**

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges flange kits nipples.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

### **3.13 EXAMINATION OF VALVES**

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

### **3.14 VALVE INSTALLATION**

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install chain wheels on operators for butterfly and gate valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
- F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.
  2. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
  3. Lift Check Valves: With stem upright and plumb.
- G. Install valve tags. Comply with requirements in Division 22 for valve tags and schedules.

### 3.15 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices in Division 22.
- B. Comply with requirements for pipe hanger, support products, and installation in Division 22.
1. Vertical Piping: MSS Type 8 or 42, clamps.
  2. Individual, Straight, Horizontal Piping Runs:
  3. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
  4. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
  5. Longer than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
  6. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  7. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/2 and NPS 2 DN 40 and DN 50: 60 inches 1500 mm with 3/8-inch 10-mm rod.
  2. NPS 3 DN 80: 60 inches 1500 mm with 1/2-inch 13-mm rod.
  3. NPS 4 and NPS 5 DN 100 and DN 125: 60 inches 1500 mm with 5/8-inch 16-mm rod.
  4. NPS 6 and NPS 8 DN 150 and DN 200: 60 inches 1500 mm with 3/4-inch 19-mm rod.
  5. NPS 10 and NPS 12 DN 250 and DN 300: 60 inches 1500 mm with 7/8-inch 22-mm rod.
  6. Spacing for 10-foot 3-m lengths may be increased to 10 feet 3 m. Spacing for fittings is limited to 60 inches 1500 mm.
- F. Install supports for vertical cast-iron soil piping every 15 feet 4.5 m.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 DN 20 and Smaller: 60 inches 1500 mm with 3/8-inch 10-mm rod.
  2. NPS 1 and NPS 1-1/4 DN 25 and DN 32: 72 inches 1800 mm with 3/8-inch 10-mm rod.
  3. NPS 1-1/2 and NPS 2 DN 40 and DN 50: 96 inches 2400 mm with 3/8-inch 10-mm rod.
  4. NPS 2-1/2 DN 65: 108 inches 2700 mm with 1/2-inch 13-mm rod.
  5. NPS 3 to NPS 5 DN 80 to DN 125: 10 feet 3 m with 1/2-inch 13-mm rod.
  6. NPS 6 DN 150: 10 feet 3 m with 5/8-inch 16-mm rod.
  7. NPS 8 DN 200: 10 feet 3 m with 3/4-inch 19-mm rod.
- H. Install supports for vertical copper tubing every 10 feet 3 m.
- I. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 DN 32 and Smaller: 84 inches 2100 mm with 3/8-inch 10-mm rod.
  2. NPS 1-1/2 DN 40: 108 inches 2700 mm with 3/8-inch 10-mm rod.



3. NPS 2 DN 50: 10 feet 3 m with 3/8-inch 10-mm rod.
  4. NPS 2-1/2 DN 65: 11 feet 3.4 m with 1/2-inch 13-mm rod.
  5. NPS 3 and NPS 3-1/2 DN 80 and DN 90: 12 feet 3.7 m with 1/2-inch 13-mm rod.
  6. NPS 4 and NPS 5 DN 100 and DN 125: 12 feet 3.7 m with 5/8-inch 16-mm rod.
  7. NPS 6 DN 150: 12 feet 3.7 m with 3/4-inch 19-mm rod.
  8. NPS 8 to NPS 12 DN 200 to DN 300: 12 feet 3.7 m with 7/8-inch 22-mm rod.
- J. Install supports for vertical steel piping every 15 feet 4.5 m.
- K. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 DN 32 and Smaller: 84 inches 2100 mm with 3/8-inch 10-mm rod.
  2. NPS 1-1/2 DN 40: 108 inches 2700 mm with 3/8-inch 10-mm rod.
  3. NPS 2 DN 50: 10 feet 3 m with 3/8-inch 10-mm rod.
  4. NPS 2-1/2 DN 65: 11 feet 3.4 m with 1/2-inch 13-mm rod.
  5. NPS 3 and NPS 3-1/2 DN 80 and DN 90: 12 feet 3.7 m with 1/2-inch 13-mm rod.
  6. NPS 4 and NPS 5 DN 100 and DN 125: 12 feet 3.7 m with 5/8-inch 16-mm rod.
  7. NPS 6 DN 150: 12 feet 3.7 m with 3/4-inch 19-mm rod.
  8. NPS 8 to NPS 12 DN 200 to DN 300: 12 feet 3.7 m with 7/8-inch 22-mm rod.
- L. Install supports for vertical stainless-steel piping every 15 feet 4.5 m.
- M. Install vinyl-coated hangers for CPVC piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1 DN 25 and Smaller: 36 inches 900 mm with 3/8-inch 10-mm rod.
  2. NPS 1-1/4 to NPS 2 DN 32 to DN 50: 48 inches 1200 mm with 3/8-inch 10-mm rod.
  3. NPS 2-1/2 to NPS 3-1/2 DN 65 to DN 90: 48 inches 1200 mm with 1/2-inch 13-mm rod.
  4. NPS 4 and NPS 5 DN 100 and DN 125: 48 inches 1200 mm with 5/8-inch 16-mm rod.
  5. NPS 6 DN 150: 48 inches 1200 mm with 3/4-inch 19-mm rod.
  6. NPS 8 DN 200: 48 inches 1200 mm with 7/8-inch 22-mm rod.
- N. Install supports for vertical CPVC piping every 60 inches 1500 mm for NPS 1 DN 25 and smaller, and every 72 inches 1800 mm for NPS 1-1/4 DN 32 and larger.
- O. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

### **3.16 CONNECTIONS**

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect water piping to water-service piping with shutoff valve; extend and connect to the following:
1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
  2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
  3. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

4. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

### **3.17 IDENTIFICATION**

- A. Identify system components. Comply with requirements for identification materials and installation in Division 22.
- B. Label pressure piping with system operating pressure.

### **3.18 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
  1. Piping Inspections:
    - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
  2. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
  3. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
  4. Piping Tests:
    - a. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.
    - b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
    - c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
    - d. Cap and subject piping to static water pressure of 50 psig 345 kPa above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
    - e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
    - f. Prepare reports for tests and for corrective action required.
- B. Domestic water piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.19 TESTING AND ADJUSTING - GENERAL

#### A. Scope

1. Test and adjust plumbing systems as specified and as required by authorities that have jurisdiction. Perform tests recommended by manufacturers of materials and equipment. This requirement may be waived by Architect.
2. Testing, balancing, and adjusting shall in no way relieve guarantee requirements.
3. Furnish instruments, equipment, material, and labor necessary to conduct tests.
4. All systems shall be thoroughly adjusted for specified operation. All mechanical equipment shall be adjusted for flow, temperature, etc. of fluid. The entire hot water circulation system shall be thoroughly balanced so hot water draw from fixtures shall be as quickly available as possible. Pumps, relief valves and pressure reducing valves shall be adjusted as required by the Engineer. Submit in writing to the Engineer upon completion of this work that it is completed and ready for use.

#### B. Before date of acceptance, furnish Architect with certificates of testing and inspection indicating approval of authorities having jurisdiction and conformance with requirements of Contract Documents.

#### C. General

1. Submit proposed test procedures, recording forms, and test equipment for review before testing.
2. Notify Architect and authorities involved at least 48 hours before testing and inspection.
3. Do not paint, cover or conceal work before testing, inspecting and obtaining approval; this includes backfilling and application of insulation.
4. Costs of repairs and restoration of work of other trades and of existing building surfaces or material damaged during cleaning or testing shall be borne by trade performing cleaning or testing.

#### D. No tests shall be started until systems have been cleaned as described under Cleaning paragraph. Provide temporary piping and connections for testing, flushing, or draining systems to be tested.

1. Repair or replace leaks, damage and defects that result from tests to like-new condition. Remove and replace defective materials with acceptable materials.
2. Piping and joints shall be made tight without caulking. Continue tests until systems operate without adjustments and repair to equipment or piping.
3. Provide testing instruments, force pumps, gauges, equipment and labor necessary to conduct tests. Instruments used for testing and balancing shall have been calibrated within six months before balancing. Instrument calibration shall be certified.
4. Submit six copies of complete testing and balancing report to Architect for review.

#### E. Final test shall be made after vertical and horizontal pipes and roughing-in have been run and before sewer or fixture connection is made.

1. After soils, wastes, and storm lines, etc. have been installed, outlets shall be temporarily plugged up.
2. Test piping and check for leakage.
3. Retesting after leaks are repaired shall be at no additional cost.

#### F. Pressurized Piping Systems

1. Leak tests shall be conducted in accordance with ANSI applicable codes and as specified herein.
2. Test piping of various systems before covered or furred in.
3. Tests shall be witnessed by Architect and pronounced satisfactory before pressure is removed or any water drained off.

4. Equipment shall be valved off or removed during test if equipment pressure rating is less than test pressure.
5. Retest systems after leaks are repaired within Contract Price.

G. Potable Water System Test

1. Certification of the potable water system integrity shall be required where separate systems of potable and non-potable water are provided to supply plumbing fixtures.
2. Fill potable water system to capacity with clean clear water. Introduce water at top of piping system (hot and cold). During filling, introduce green food coloring dye into piping system. A floor-by-floor survey shall be conducted. Operate each outlet (hot and cold) connected to potable water system until coloring has been observed. A method of maintaining the level of water and coloring shall be employed in order to make-up the drawn off amounts. A survey sheet shall indicate each floor and the room number sequentially.
3. This survey is required to be performed after all pressure testing and flushing of the piping system but before sterilization, further it is required that all fixtures connected to the potable water system be installed prior to the test.

H. Examine Part 2 for supplemental testing requirements.

### 3.20 TESTING: PIPING SYSTEMS

A. General

1. Piping systems shall be subjected to testing water or air as noted and shall hold tight at the pressure head stated for the time interval required without adding air or water. While any system is being tested, required head or pressure shall be maintained until joints are inspected.
2. Tests shall be witnessed by inspector having jurisdiction and the Architect with 48-hour notice given these authorities.
3. Equipment, material and labor required for testing of various systems or part thereof shall be provided by Plumbing Contractor.

B. Sanitary, Kitchen Waste, Vent and Rain Water Conductor Systems

1. Water test shall be applied to drainage systems either in their entirety or in sections as required, after rough piping has been installed.
2. If applied to entire system, openings in piping system shall be tightly closed, except the highest opening, and system filled with water to point of overflow.
3. If system is tested in sections, each opening shall be tightly closed except highest opening in the section under test, and each section shall be filled with water but no section shall be tested with less than a 10 foot head of water.
4. In testing successive sections, at least upper 10 feet of next preceding section shall be tested so that no joint of piping in building, except the uppermost 10 feet of the system shall be submitted to a test of less than a 10 foot head of water.
5. Water shall be kept in system for at least 30 minutes before inspection starts; the system shall then be made tight at all points.
6. Points of drainage systems tested with air instead of water shall be tested by attaching an air compressor testing apparatus to suitable opening and, after closing all other inlets or outlets, forcing air into systems until a uniform gauge pressure of 5 psi or sufficient pressure to balance a column of mercury 10 inches high. Pressure shall be held without introduction of additional air for a period of at least 15 minutes.

C. Water Piping Systems

1. Upon completion of water supply systems or section thereof, as required, system shall be tested and proved tight under 1.5 times the operating system pressure and a minimum of

150 psi. Gauge shall be located on lowest new floor and pressure shall hold for a period of one hour without introducing additional water. Water used for testing shall be from a potable source of supply.

2. Filtered water piping system shall be tested with filtered or distilled water to a pressure of 100 psi for one hour.

D. Natural Gas Piping Systems

1. Upon completion of gas piping system or section thereof, as required, test by attaching an air compressor testing apparatus to any suitable opening and, after closing all other inlets or outlets, force air into the system until a uniform pressure of at least 10 inches mercury or 3 lb. gauge for a period of no less than 60 minutes for each 500 cubic feet of pipe volume without showing any drop in pressure. Pressure shall be measured with a mercury manometer, slope gauge, or an equivalent device calibrated to read in increments of no greater than 1/10 lbs.
2. Test all elevated pressure gas piping at 15 psi for 24 hours. Pressure shall be measured with a mercury manometer, slope gauge, or an equivalent device calibrated to read in increments of no greater than 1/10 lbs.

E. Testing Summary

System	Test Medium	Test Pressure	Test Duration
Drainage and Vent (All Systems)	Water	10 feet	30 minutes
Water (All Systems)	Water	150 psig min or 1.5 operating pressure	1 hour
Natural Gas (High Pressure)	Air	15 psig min or 1.5 operating pressure	24 hours
Natural Gas (Low Pressure)	Air	10 inch mercury minimum for each 500 cubic feet of pipe volume	1 hour
Ejector Discharge/Pumped Piping System	Water	50 psig min. or 1.5 times system pressure	1 hour

F. Defective Work: If inspection or tests show defects, such defective work or material shall be replaced and inspection and tests shall be repeated. Repairs to piping shall be made with new material. No caulking of screwed joints or holes shall be acceptable.

G. Additional Tests

1. Provide additional tests such as smoke pressure tests as required by regulations or as directed by authorities making the inspection.
2. Provide for any repeated test as directed by the Architect, to make all systems tight as required.
3. Visual inspections of joints and valves shall be made as directed by the Architect.

### 3.21 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
5. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
6. Adjust calibrated balancing valves to flows indicated.
7. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
8. Remove and clean strainer screens. Close drain valves and replace drain plugs.
9. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
10. Check plumbing specialties and verify proper settings, adjustments, and operation.

### 3.22 BALANCING OF HOT WATER SYSTEMS

A. Building Distribution System

1. All circuits and sub circuits shall be flow and temperature balanced such that hot water positive flow is achieved in each branch circuit of the building hot water systems
2. See drawing detail sheets and specification section pipe table A10 for flow and balancing valve spec options. The specified products indicate either integral flow or flow/temperature balancing devices, assure the installed devices meet these specifications

3. Indicate on a riser diagram the type of balancing device use, method of calibration and proposed flow in each branch circuit of the hot water piping network for each hot water system
- B. Building Main Hot Water Distribution Pumps
1. Balance flows to the main Thermostatic Hot Water Mixing Valves according to manufacturer's instructions
  2. Provide plastic tags on each circuit indicating the flow and balancing valve position to the Mixing valves and then to the water heaters
- C. Submissions
1. Submit a report indicating the actual flow and temperature in each circuit described in item C above. The report shall designate the following:
    2. Time to achieve hot water at the remote hot water faucet in the circuit
    3. Hot water temperature achieved
    4. Setting on circuit setter
  5. For the circuits at the outlets of hot water circulation pumps, indicate the following:
    6. The actual flow and temperature into Temperature Mixing Valve
    7. The actual flow and temperature back to the heaters and/or storage tanks

### 3.23 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
  2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
  3. Flush piping system with clean, potable water until dirty water does not appear at outlets.
  4. Fill and isolate system according to either of the following:
    - a. Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
    - b. Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
  5. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
  6. Repeat procedures if biological examination shows contamination.
  7. Submit water samples in sterile bottles to authorities having jurisdiction.
- B. Clean non-potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
  2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
  3. Flush piping system with clean, potable water until dirty water does not appear at outlets.
  4. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

**END OF SECTION 22 11 10**

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## **SECTION 22 11 19 - WATER PIPING SPECIALTIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Vacuum breakers.
  - 2. Backflow preventers.
  - 3. Central thermostatic water mixing valves
  - 4. Strainers.
  - 5. Hose bibbs.
  - 6. Drain valves.
  - 7. Water-hammer arresters.
  - 8. Air vents.
  - 9. Trap-seal primer valves.
  - 10. Specialty valves.
  - 11. Flexible connectors.
  
- B. All pipe, fittings, and valves used in this distribution system and installed after January 4, 2014 must comply with the new Federal Mandate known as the "Reduction of Lead in Drinking Water Act-2014". Any product pipe, fittings or valve installed after the enactment date that does not comply, shall be removed and changed by this contractor at Contractor expense to comply with the Federal Law

#### **1.3 ACTION SUBMITTALS**

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

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES**

- A. All pipe, fittings, and valves used in this distribution system and installed after January 4, 2014 must comply with the new Federal Mandate known as the "Reduction of Lead in Drinking Water Act-2014". Therefore, after the enactment date of 1/4/14, all products installed must comply. Any product pipe, fittings, valve, or specialty item installed after the enactment date that does not comply, shall be removed and changed by this contractor at his/her own expense to comply with the Federal Law
- B. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14.

### **2.2 PERFORMANCE REQUIREMENTS**

- A. Minimum Working Pressure for Water Piping Specialties: 150 psig unless otherwise indicated.

### **2.3 VACUUM BREAKERS**

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Ames Co.
    - b. Cash Acme.
    - c. Conbraco Industries, Inc.
    - d. FEBCO.
    - e. Watts; a Watts Water Technologies company.
  - 2. Standard: ASSE 1001.
  - 3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
  - 4. Body: Bronze.
  - 5. Inlet and Outlet Connections: Threaded.
  - 6. Finish: Rough bronze.
  - 7. Basis of Design for Cold Water: Watts LF288A, Cash Acme V101.
  - 8. Basis of Design for Hot Water: Cash Acme V101.
- B. Hose-Connection Vacuum Breakers :
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Cash Acme.
    - b. Conbraco Industries, Inc.
    - c. Watts; a Watts Water Technologies company.
    - d. Woodford Manufacturing Company.

2. Standard: ASSE 1011.
3. Body: Bronze, non-removable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Chrome or nickel plated Rough bronze. Match finish of HB
6. Basis of Design: Cash Acme VB-222.

C. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Ames Co.
  - b. Conbraco Industries, Inc.
  - c. FEBCO.
  - d. Watts; a Watts Water Technologies company.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig 35 kPa maximum, through middle third of flow range.
5. Accessories:
  - a. Valves: Ball type, on inlet
6. Basis of Design Cold Water: Watts series LF800M4QT
7. Basis of Design Hot Water: Cash Acme PVB
8. Basis of Design Freeze Proof Cold Water: Watts series 800M4FR

## 2.4 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ames Co.
  - b. Conbraco Industries, Inc.
  - c. FEBCO.
  - d. Watts; a Watts Water Technologies company.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 8 PSIG maximum, through middle third of flow range.
5. Body: Bronze for NPS 2 and smaller; steel with interior lining that complies with AWWA C550 or that is FDA approved or stainless steel for NPS 2-1/2 and larger.
6. End Connections: Threaded for NPS 2 and smaller; flanged or mechanical for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight-through flow.
8. Accessories:
  - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.

- b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
  - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
9. Basis of Design: Watts 957, Watts 009-QT-S
  10. Basis of Design: Special Flow Patterns: Febco 825YA, Febco 880V

**B. Backflow-Preventer Test Kits :**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Conbraco Industries, Inc.
  - b. FEBCO.
  - c. Watts; a Watts Water Technologies company.
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

**2.5 WATER PRESSURE-REDUCING VALVES**

**A. Water Regulators : See drawings for sizes, pressures and flow rates**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Cash Acme.
  - b. Conbraco Industries, Inc.
  - c. Watts; a Watts Water Technologies company.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Size: See drawings.
5. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3.
6. Valves for Booster Heater Water Supply: Include integral bypass.
7. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

**2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES**

**A. Individual-Fixture, Water Tempering Valves :**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Conbraco Industries, Inc.
  - b. Lawler Manufacturing Company, Inc.
  - c. Leonard Valve Company.

- d. Watts; a Watts Water Technologies company.
- 2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
- 3. Pressure Rating: 125 psig 860 kPa minimum unless otherwise indicated.
- 4. Body: Bronze body with corrosion-resistant interior components.
- 5. Temperature Control: Adjustable.
- 6. Inlets and Outlet: Threaded.
- 7. Finish: Rough or chrome-plated bronze.
- 8. Tempered-Water Setting: 110 deg F.
- 9. Basis of Design: Zurn Model ZW3870XLT, Watts LFMMV point of use

## 2.7 Central Digital, Thermostatic, Water Mixing Valves:

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Armstrong International, Inc.
  - 2. Powers.
- B. General Requirements
  - 1. Standard: ASSE 1017.
  - 2. Pressure Rating: 125 psig minimum unless otherwise indicated.
  - 3. Material: manufacturer standard corrosion-resistant interior components.
  - 4. Accessories: Digital temperature control, package factory piped and factory wired for single point connections.
  - 5. The system is ready for connection to the Building Automation System
  - 6. Tempered-Water Setting: See drawings.
  - 7. Piping Finish: Copper.
- C. 80 Digital Mixing Center (DMC)
  - 1. Number of Units: Two (2) Digital Re-Circulating Valves shall be supplied pre-piped in parallel and pressure tested as a lead free Digital Mixing Center complete with inlet hot water, inlet cold water, outlet mixed water, inlet re-circulation return water and outlet return to heater water connections.
  - 2. DMC shall comprise check valves, strainers, thermometers, pressure gauges, ball valves, inlet hot water to outlet mixed water by-pass and shall be mounted onto an enameled steel frame.
  - 3. Digital Re-Circulating Valves (DRV)
    - a. Each Re-Circulating Valve shall be digital of lead free stainless steel/polymer construction.
    - b. Each DRV shall have 3" inlet/outlet connections, deliver a mixed water flow of 165 GPM @ 7.5ft/sec and shall have no minimum system draw off requirement.
    - c. Each DRV shall have all of the following operational capabilities:
      - 1) +/- 2F water temperature control
      - 2) 2F minimum inlet to outlet water temperature differential
      - 3) Automatic shutoff of hot water flow upon cold water inlet supply failure.
      - 4) Automatic shutoff of hot water flow in the event of a power failure
      - 5) Programmable set point range of 81-158°F (27-70°C)
      - 6) Programmable thermal disinfection mode.
      - 7) Programmable 1st level hi/lo temp alarm display
      - 8) Programmable temperature error level for safety shutdown
  - 4. DRV shall have all of the following connectivity capabilities:

- a. SPCO relay outputs which are energized during operation.
  - b. LCD display which indicates: set point, delivered temperature, error codes and alarm conditions.
  - c. MODBUS 485 port for remote set point adjustment and remote operating temperature visibility.
  - d. RS485 Serial Port for connection to a performance matched hot water monitoring system.
5. DRV shall be compliant with ASSE Standard 1017 and CSA B125 and so certified and identified.
  6. DRV shall be UL listed and identified.
  7. Warranty: standard manufacturer warranty of 5 years on components
  8. Building Automation System/Web Interface
    - a. Digital Re-Circulating Valve shall be supplied with an integral Hot Water Management System Console.
    - b. Hot Water Management System Console shall enable direct onward connection to Building Automation Systems via either ModBus, Bacnet™ and LonWorks™ protocols\* with an Ethernet port for access via a web browser.
    - c. Hot Water Management System Console shall receive and communicate the following inputs.
      - 1) Set Point
      - 2) Inlet/Outlet Temperature
      - 3) Over Temperature Alert
        - a) On over temperature for 20 seconds or more, the system shall shut down and default to cold water. An alarm condition shall be reported to the BMS system
    - d. Hot Water Management System Console shall receive and communicate the following self-diagnostic error messages.
      - 1) Over Temperature Error
      - 2) PCB Error
      - 3) Thermistor Error
      - 4) Motor Error/Emergency Mode
      - 5) Battery Error
  9. Basis of Design: Armstrong Digital Re-Circulation Valve the Brain with BrainScan - Model DMC80-80BS.

## 2.8 STRAINERS FOR WATER PIPING

### A. Y-Pattern Strainers

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
  - a. Strainers NPS 2 DN 50 and Smaller: 0.020 inch 0.51 mm.
  - b. Strainers NPS 2-1/2 to NPS 4 DN 65 to DN 100: 0.045 inch 1.14 mm.
  - c. Strainers NPS 5 and Larger: 0.10 inch.

6. Drain: 1/2 to 2 inch pipe plug 2-1/2 inches and larger - Factory-installed, hose-end drain valve.

## **2.9 HOSE BIBBS**

### **A. Hose Bibbs**

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 DN 15 or DN 20 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig 860 kPa.
7. Vacuum Breaker: Integral non-removable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Chrome or nickel plated.
9. Finish for Service Areas: Chrome or nickel plated.
10. Finish for Finished Rooms, including toilet rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.
16. Basis of Design: Watts

## **2.10 DRAIN VALVES**

### **A. Ball-Valve-Type, Hose-End Drain Valves**

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig 2760-kPa minimum CWP.
3. Size: NPS 3/4 DN 20.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

### **B. Stop-and-Waste Drain Valves**

1. Standard: MSS SP-110 for ball valves or MSS SP-80 for gate valves.
2. Pressure Rating: 200-psig 1380-kPa minimum CWP or Class 125.
3. Size: NPS 3/4 DN 20.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 DN 6 side outlet with cap.

## **2.11 WATER-HAMMER ARRESTERS**

### **A. Water-Hammer Arresters**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. AMTROL, Inc.
  - b. MIFAB, Inc.
  - c. Precision Plumbing Products.
  - d. Sioux Chief Manufacturing Company, Inc.
  - e. Smith, Jay R. Mfg. Co.
  - f. Watts; a Watts Water Technologies company.
2. Standard: ASSE 1010 or PDI-WH 201.
  3. Type: Metal bellows or Copper tube with piston.
  4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

## **2.12 AIR VENTS**

### **A. Bolted-Construction Automatic Air Vents**

1. Body: Bronze.
2. Pressure Rating and Temperature: 125-psig 860-kPa minimum pressure rating at 140 deg F 60 deg C.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 DN 15 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

### **B. Welded-Construction Automatic Air Vents**

1. Body: Stainless steel.
2. Pressure Rating: 150-psig 1035-kPa minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 DN 10 minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

## **2.13 TRAP-SEAL PRIMER DEVICE**

### **A. Supply-Type, Trap-Seal Primer Device**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. MIFAB, Inc.
  - b. Precision Plumbing Products.
  - c. Sioux Chief Manufacturing Company, Inc.
  - d. Smith, Jay R. Mfg. Co.
  - e. Watts; a Watts Water Technologies company.
2. Standard: ASSE 1018.



3. Pressure Rating: 125 psig 860 kPa minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 DN 15 threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 DN 15 threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.
8. Basis of Design: Precision Plumbing model PRO1-500 Brass
9. Precision Plumbing model PRO1-ULP500 chrome

## **2.14 TRAP-SEAL PRIMER SYSTEMS**

### **A. Trap-Seal Primer Systems**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Precision Plumbing Products.
2. Standard: ASSE 1044.
3. Piping: NPS 3/4, ASTM B 88, Type L DN 20, ASTM B 88M, Type B; copper, water tubing.
4. Cabinet: Surface-mounted steel box with stainless-steel cover.
5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
  - a. 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.
6. Vacuum Breaker: ASSE 1001.
7. Size Outlets: NPS 1/2 DN 15.

## **2.15 FLEXIBLE CONNECTORS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  1. Flexicraft Industries.
  2. Metraflex Company (The).
  3. Universal Metal Hose.
- B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
  1. Working-Pressure Rating: Minimum 250 psig 1725 kPa.
  2. End Connections NPS 2 DN 50 and Smaller: Threaded copper pipe or plain-end copper tube.
  3. End Connections NPS 2-1/2 DN 65 and Larger: Flanged copper alloy.
- C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
  1. Working-Pressure Rating: Minimum 250 psig 1725 kPa.
  2. End Connections NPS 2 DN 50 and Smaller: Threaded steel-pipe nipple.
  3. End Connections NPS 2-1/2 DN 65 and Larger: Flanged steel nipple.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
  - 1. Locate backflow preventers in same room as connected equipment or system.
  - 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or approved equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
  - 3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.
- C. Install water-control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
  - 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Install Y-pattern strainers for water on supply side of each control valve water pressure-reducing valve solenoid valve and pump.
- G. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch 38-by-89-mm fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Division 06.
- H. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.
  - 1. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch 38-by-89-mm fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Division 06.
- I. Set non-freeze, non-draining-type post hydrants in concrete or pavement.
- J. Set freeze-resistant yard hydrants with riser pipe in concrete or pavement. Do not encase canister in concrete.
- K. Install water-hammer arresters in water piping according to PDI-WH 201.
- L. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
- M. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- N. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

- O. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

### **3.2 CONNECTIONS**

- A. Comply with requirements for ground equipment in Division 26.
- B. Fire-retardant-treated-wood blocking is specified in Division 26 for electrical connections.

### **3.3 LABELING AND IDENTIFYING**

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  - 1. Reduced-pressure-principle backflow preventers.
  - 2. Water pressure-reducing valves.
  - 3. Calibrated balancing valves.
  - 4. Primary, thermostatic, water mixing valves.
  - 5. Supply-type, trap-seal primer valves.
  - 6. Trap-seal primer systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22.

### **3.4 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
  - 1. Test each pressure vacuum breaker reduced-pressure-principle backflow preventer double-check, backflow-prevention assembly and double-check, detector-assembly backflow preventer Insert type according to authorities having jurisdiction and the device's reference standard.
- B. Water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### **3.5 ADJUSTING**

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

**END OF SECTION 22 11 19**

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## **SECTION 22 11 23 - WATER PUMPS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Horizontally or vertically mounted, in-line, close-coupled centrifugal pumps.
  - 2. Motors
  - 3. Controls

#### **1.3 DEFINITIONS**

- A. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include materials of construction, rated capacities, certified performance curves with operating points plotted on curves, operating characteristics, electrical characteristics, and furnished specialties and accessories.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For water pumps to include in operation and maintenance manuals.

#### **1.6 QUALITY ASSURANCE**

- A. 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.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

#### **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

### **PART 2 - PRODUCTS**

#### **2.1 HORIZONTALLY OR VERTICALLY MOUNTED, IN-LINE, CLOSE-COUPLED CENTRIFUGAL PUMPS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Armstrong Pumps, Inc.
  - 2. Bell & Gossett; a Xylem brand.
  - 3. Grundfos Pumps
  - 4. TACO Incorporated.
- B. Description: Factory-assembled and -tested, in-line, single-stage, close-coupled, overhung-impeller centrifugal pumps designed for installation with pump and motor shaft mounted horizontal.

C. Close Coupled Pumps.

1. The pumps shall be single stage horizontal in-line design. The seal shall be serviceable without disturbing the piping connections. The capacities and characteristics shall be as called for in the plans/schedules.
2. Pump shall be constructed of ASTM A48 class 30 cast iron. The pump casing shall be drilled and tapped for gauge ports on both the suction and discharge connections.
3. All casings shall be flanged connections.
4. Pumps shall be rated for domestic water service
5. The impeller shall be ASTM C87500 or C89833 bronze and hydraulically balanced. The impeller shall be dynamically balanced to ANSI Grade G6.3 and shall be fitted with a holding taper and left handed 431 series stainless steel bolt. The impeller shall be cast by the hydraulically efficient lost foam technique to ensure repeatability of high quality.
6. The pump shall incorporate a dry shaft design to prevent the circulating fluid from contacting the shaft. The pump shaft shall be AISI 1045 carbon steel with field replaceable copper nickel 90-10 shaft sleeve. In order to improve serviceability and reduce the cost of ownership the shaft sleeve must be slip on (press on not allowable) and must be easily replaced in the field.
7. The pump shall be fitted with a single mechanical seal, with EPT elastomers and Carbon/Ceramic faces, rated up to 250 deg F. The pump shall be coupled to a NEMA 56C face motor with threaded on shaft extension.
8. The manufacturer shall standardize on one mechanical seal throughout the entire range of the family of pumps. The manufacturer shall not use multiple part numbers for the same part.

D. Motor: Single speed, with grease-lubricated ball bearings; and resiliently or rigidly mounted to pump casing.

E. Capacities and Characteristics: See Drawing Schedule

## 2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

## 2.3 CONTROLS

A. Timers: Electric, for control of hot-water circulation pump.

1. Type: Programmable, seven-day clock with manual override on-off switch.
2. Enclosure: NEMA 250, Type 1, suitable for wall mounting.
3. Operation of Pump: On or off.
4. Transformer: Provide if required.
5. Power Requirement: 120-V ac
6. Programmable Sequence of Operation: Up to two on-off cycles each day for seven days

## PART 3 - EXECUTION

### 3.1 EXAMINATION

A. Examine roughing-in of -water-piping system to verify actual locations of connections before pump installation.

### **3.2 PUMP INSTALLATION**

- A. Comply with HI 1.4.
- B. Install in-line, seal-less centrifugal pumps with shaft horizontal unless otherwise indicated.
- C. Install horizontally mounted, in-line, separately coupled and close-coupled centrifugal pumps with shaft(s) horizontal.
- D. Install vertically mounted, in-line, close-coupled centrifugal pumps with shaft vertical.
- E. Install continuous-thread hanger rods and spring hangers with vertical-limit stop of size required to support pump weight.
  - 1. Comply with requirements for vibration isolation devices specified in Division 22. Fabricate brackets or supports as required.
  - 2. Comply with requirements for hangers and supports specified in Division 22.
- F. Install pressure switches in water supply piping.
- G. Install thermostats in hot-water return piping.
- H. Install timers on wall.
- I. Install time-delay relays in piping between water heaters and hot-water storage tanks.

### **3.3 CONNECTIONS**

- A. Comply with requirements for piping specified in Piping Sections of this specification. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to pumps to allow service and maintenance.
- C. Connect water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles.
  - 1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
    - a. Horizontally mounted, in-line, close-coupled centrifugal pumps.
    - b. Vertically mounted, in-line, close-coupled centrifugal pumps.
    - c. Comply with requirements for flexible connectors specified in Division 22.
- D. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected piping. Comply with requirements for valves specified in Division 22 and comply with requirements for strainers specified in Division 22.
  - 1. Install pressure gage and snubber at suction of each pump and pressure gage and snubber at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Division 22.
- E. Connect pressure switches, thermostats, time-delay relays, and timers to pumps that they control.
- F. Interlock pump between water heater and hot-water storage tank with water heater burner and time-delay relay.

### **3.4 IDENTIFICATION**

- A. Comply with requirements for identification specified in Division 22 for identification of pumps.

### **3.5 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Check piping connections for tightness.
3. Clean strainers on suction piping.
4. Set pressure switches, thermostats, timers, and time-delay relays for automatic starting and stopping operation of pumps.
5. Perform the following startup checks for each pump before starting:
  - a. Verify bearing lubrication.
  - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
  - c. Verify that pump is rotating in the correct direction.
6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

### **3.6 ADJUSTING**

- A. Adjust water pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust initial temperature set points.
- C. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

**END OF SECTION 22 11 23**

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## **SECTION 22 13 19 - SANITARY WASTE PIPING SPECIALTIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Cleanouts.
  - 2. Floor drains.
  - 3. Through-penetration firestop assemblies.
  - 4. Miscellaneous sanitary drainage piping specialties.
  - 5. Flashing materials.
- B. Related Requirements:
  - 1. Division 33 for storm draining piping and piping specialties outside the building.

#### **1.3 DEFINITIONS**

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene plastic.
- D. PE: Polyethylene plastic.
- E. PP: Polypropylene plastic.
- F. PVC: Polyvinyl chloride plastic.

#### **1.4 ACTION SUBMITTALS**

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.

#### **1.6 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.



## 1.7 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- 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.

## 1.8 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate size and location of roof penetrations.

## PART 2 - PRODUCTS

### 2.1 CLEANOUTS

- A. Exposed Metal Cleanouts
  - 1. ASME A112.36.2M, Cast-Iron Cleanouts:
    - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
      - 1) Smith, Jay R. Mfg. Co.
      - 2) Watts; a Watts Water Technologies company.
- B. Cast-Iron Wall Cleanouts
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. MIFAB, Inc.
    - b. Smith, Jay R. Mfg. Co.
    - c. Watts; a Watts Water Technologies company.
  - 2. Standard: ASME A112.36.2M. Include wall access.
  - 3. Size: Same as connected drainage piping.
  - 4. Body: as required to match connected piping.
  - 5. Closure: Countersunk or raised-head, drilled-and-threaded brass plug.
  - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
  - 7. Wall Access: Square, nickel-bronze wall-installation frame and cover.

### 2.2 FLOOR DRAINS

- A. Cast-Iron Floor Drains : SEE DRAWING SCHEDULE SHEET

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. MIFAB, Inc.
  - b. Smith, Jay R. Mfg. Co.
  - c. Watts; a Watts Water Technologies company.

## **2.3 THROUGH-PENETRATION FIRESTOP ASSEMBLIES**

### **A. Through-Penetration Firestop Assemblies**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. ProSet Systems Inc.
  - b. Hilti
  - c. 3M
2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.

## **2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES**

### **A. Open Drains**

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting two sizes larger than connected pipe.

### **B. Deep-Seal Traps**

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
  - a. NPS 2: 4-inch-- minimum water seal.
  - b. NPS 2-1/2 and Larger: 5-inch-- minimum water seal.

### **C. Floor-Drain, Trap-Seal Primer Fittings**

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

D. Air-Gap Fittings

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device

1. Description: Manufactured, cast-iron fitting, with clamping device that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings

1. Description: Counter flashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Expansion Joints

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

## 2.5 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz. /sq. ft.
2. Vent Pipe Flashing: 8 oz. /sq. ft.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
  - 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
  - 2. Locate at each change in direction of piping greater than 45 degrees.
  - 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
  - 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
  - 1. Position floor drains for easy access and maintenance.
  - 2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
    - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
    - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
    - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
  - 3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
  - 4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
- F. Assemble open drain fittings and install with top of hub 2 inches above floor.
- G. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- H. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
  - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
  - 2. Size: Same as floor drain inlet.
- I. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- J. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.
- K. Install vent caps on each vent pipe passing through roof.

- L. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- M. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- N. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

### **3.2 CONNECTIONS**

- A. Install piping adjacent to equipment to allow service and maintenance.
- B. Ground equipment according to Division 26.
- C. Connect wiring according to Division 26.

### **3.3 FLASHING INSTALLATION**

- A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
  - 1. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
  - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
  - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
  - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Install flashing for piping passing through roofs with counter flashing or commercially made flashing fittings, according to Division 07.
- F. Fabricate and install flashing and pans, sumps, and other drainage shapes.
- G. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22.

### **3.4 FIELD QUALITY CONTROL**

- A. Tests and Inspections:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

### **3.5 PROTECTION**

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

**END OF SECTION 22 13 19**

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## **SECTION 22 13 29 - SANITARY SEWERAGE PUMPS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Basins
  - 2. Packaged, submersible sewage-pump units
  - 3. Packaged elevator sump pump

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles.
- B. Wiring Diagrams: For power, signal, and control wiring.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

#### **1.5 QUALITY ASSURANCE**

- A. 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.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

#### **1.7 COORDINATION**

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

#### **1.8 WARRANTY**

- A. General: periods are stipulated here for this specification section. Generally manufacturers standard warranty applies, however, longer warranty periods, if required, are stipulated in part 2

where each product is specified. The warranty periods stipulated in part 2 take priority over standard manufacturer's warranty periods specified in part 1.

- B. Warranty: Manufacturer's standard warranty – submit a form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within manufacturers standard specified warranty period. Manufacturers standard warranty must include minimum durations below
- C. Minimum Durations and Special Warrantees: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
  - 1. Structural failures including shell.
  - 2. Warranty period shall begin on the date of project substantial completion stipulated by the Architect and/or the Construction Manager
  - 3. Faulty operation of sewage pumps, controls, or accessories.
  - 4. Deterioration of metals, metal finishes, and other materials beyond normal use.

## PART 2 - PRODUCTS

### 2.1 BASINS

- A. Field fabricated cast in place concrete, watertight, square or rectangular. Provide sleeves for basin sump with top flange and sidewall openings for pipe connections.
- B. Material: Concrete
- C. Reinforcement: Mounting plates for pumps, fittings, guide-rail supports if used, and accessories.
  - 1. Anchor Flange: Same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.
- D. Basin Covers: Covers are to be square to fit configuration of the concrete sump where to attach.
  - 1. Fabricate metal cover with openings having gaskets, seals, and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections, and power cables.
  - 2. Reinforcement: Steel or cast iron, capable of supporting foot traffic for basins installed in foot-traffic areas.

### 2.2 PACKAGED, SUBMERSIBLE SEWAGE-PUMP UNITS SE-1 & SE-2

- A. **Manufacturers:** Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Flygt Pump.
  - 2. Goulds Water Technology; a Xylem brand.
  - 3. Liberty Pumps.
  - 4. Weil Pump Company.
  - 5. Zoeller Company.
- B. Packaged Sewage Pump Station:

INTERIOR PACKAGE PUMP STATION (SEWAGE)	
Equipment Tag	SE-1 & SE-2
TYPE	Solids handling centrifugal 3 inch submersible SLICER PUMPS, Duplex (2 required)
CONSTRUCTION:	Pumps to have 300 series stainless steel shafts, cast iron impellers and STAINLESS STEEL SLICING BLADES



<b>INTERIOR PACKAGE PUMP STATION (SEWAGE)</b>	
<b>Equipment Tag</b>	<b>SE-1 &amp; SE-2</b>
MOTORS	Motor(s) shall be housed in watertight cast iron shell with extended cooling fins. Oil filled motors will not be considered equal. Motor(s) shall have Class 'F' insulation and permanently lubricated double seal ball bearings. Motor(s) using sleeve type bearing will not be considered equal. Mating surfaces between the motor and bell, motor shell and seal housing shall be sealed by means of 'O' rings. The motor shaft shall be Series 300 stainless steel with keyway for positive positioning of the impeller. Carbon steel and 400 series stainless steel shafts are not considered equal.
SEALS	Dual mechanical mounted in tandem. Each seal shall have carbon rotary and ceramic stationary faces with Buna-n elastomeric and 316 SS spring. Equal to Crane type 21.
IMPELLER	Impeller: Statically and dynamically balanced, <b>ASTM A 48/A 48M, Class No. 25 A cast iron</b> design for clear wastewater handling, and keyed and secured to shaft. Impeller shall be multi-vane, semi-open type and accurately machined to the proper diameter. All impellers are to be trimmed to suit job conditions and then dynamically balanced.
LEVEL SWITCHES	Float switches UL listed narrow-angle non-mercury sensor switch with normally open contact, which closes as the float tips slightly above the horizontal plane and high water alarm. Each float switches to be equipped with 75 feet of cable. Equal to <b>WEIL</b> Series 8234 float switches.
VALVES	Furnish check valves and shut-off Ball/Butterfly valves on pump outlet piping for each pump. Manifold piping at outlet.
INLET	Furnish and install all necessary sleeves and supporting watertight sleeve packing for pump station inlet and outlet piping during concrete placement.
<b>CONTROLS</b>	
BASIN	A concrete pit shall be constructed to accept the duplex sewage pumps, rails, vent, discharge and electrical piping. Rail stud mounts shall be installed to accommodate the Pump system or compatible with the pump station manufacturer. These must be 3/4 inch anchor bolts placed to match rails supplied by the plumbing contractor. Inlet and discharge fittings created per drawings. Refer to drawings for basin waterproofing details
COVER	<b>53 inch x 53 inch</b> Square steel cover with all necessary openings and matching angle iron curb frame.
ACCESS HATCH	Access hatch placed in cover shall be provided to serve the specified pump discharge with no openings. A stainless steel float and cable bracket will be included so that floats may be serviced from outside the pit.
PUMP PULL/RAILS	Each pump shall have Weil model 2613 rail removal system. For - Sliding Bracket – Select Iron or Bronze for use with Explosion Proof Motor Guide Rails: Vertical pipes or structural members, made of galvanized steel or other corrosion-resistant metal, attached to baseplate and basin sidewall or cover. Baseplate: Corrosion-resistant metal plate, attached to basin floor, supporting guide rails and stationary elbow. Pump Yoke: Motor-mounted or casing-mounted yokes or other attachments for aligning pump during connection of flanges. Movable Elbow: Pump discharge-elbow fitting with flange, seal, and positioning device. Stationary Elbow: Fixed discharge-elbow fitting with flange that mates to movable-elbow flange and support attached to baseplate. Lifting Cable: Stainless steel; attached to pump and cover at manhole. Bolt Pump to the sliding bracket. Mount cast iron floor elbow to the Sub Base or the wet well floor. Mount Guide pipes on the floor elbow and an upper guide pipe bracket.
ELECTRICAL	<b>SEE DRAWING SCHEDULE SHEET</b>
CAPACITY	
WARRANTY	<b>See Part 1</b>
BASIS OF DESIGN	<b>Weil Pump Model 2533 submersible SLICER packaged sewage pump station</b>

### 2.3 PACKAGED OIL MINDER ELEVATOR SUMP PUMP

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Stancor Pump Co
  2. Liberty Pumps.

3. Zoeller Company
- B. Factory-assembled and -tested, automatic-operation, effluent-pump unit designed to operate in an elevator concrete sump.
- C. Equipment Tag SP-1
- D. Number of Pumps: 1 duplex
- E. Description
  1. The system shall be capable of pumping water while containing oil. The pump and oil sensor technology control system shall comply with ASME 17.1 standards. The system shall function automatically without human intervention. In addition, the system shall provide separate alarms in the event of an oil spill, high liquid level condition, or overcurrent condition due to a pump fault. All controls shall be UL 508a approved. All components of system shall be UL approved. Pump shall be approved to UL 778 and/or CSA C22.2
  2. The pump shall be designed to handle without clogging clean water, contaminated water, wastewater effluent, storm water, and other similar liquids that may contain small solids. The pump shall have integrated feet allowing it to stand on a hard bottom wet well.
  3. The power cable shall be sized according to NEC and CSA standards. The outer jacket of the cable shall be oil and water resistant thermoplastic elastomer. The power cable shall be fitted to the motor using an epoxy potted water tight cable entry system with a rubber grommet as the secondary seal and strain relief
- F. Construction:
  1. Major pump components shall be made from Stainless Steel 304 and FC-20 Cast Iron, with smooth surfaces devoid of porosity or other irregularities. All exposed fasteners shall be AISI type 316 stainless steel. Critical mating surfaces, where a watertight seal is required, shall be machined and fitted with Nitrile (Buna N) O-rings.
  2. Bearings: The pump shaft shall rotate on permanently lubricated, greased bearings. B-10 bearing life shall be a minimum of 30,000 hours at BEP. Pump designs utilizing components other than ball bearings, or those requiring supplemental guide bushings for the shaft or impeller, shall not be considered acceptable.
  3. Shaft and Rotating Assembly The common motor/pump shaft shall be of Stainless Steel (410) material that is in contact with pump's mechanical seals and shall have a polished finish and accurately machined shoulders to accommodate the bearings, seals and impeller.
  4. Motors The motor shall be capable of continuous submerged operation under water to a depth of 30 feet. The motor shall be capable of operating continuously, submerged in liquid of 40oC (104o F) without overheating. The motor shall be capable of handling up to 10 evenly spaced starts per hour. All motors shall have a voltage tolerance of +/- 10% from nominal name plate rating
  5. Seals Each pump shall be equipped with a tandem mechanical shaft seal system consisting of two independent seal assemblies with a common spring between them and a radial lip seal; providing three complete levels of sealing between the pump wet end and the motor. The mechanical seals shall operate in an oil filled chamber which is completely separate from the motor chamber. The seal faces shall be Silicon Carbide/ Silicon Carbide for the lower seal and Carbon/Ceramic for the upper seal. Metallic components of the mechanical seal shall be constructed of 300 series stainless steel.
  6. ImpellerThe impeller shall be a non-clogging, dynamically balanced, vortex design, capable of passing a 35 mm diameter spherical solid.
- G. Controls
  1. Approved to UL508 standards and housed in a gasketed NEMA 4X enclosure made up of polycarbonate and ABS. The dimensions of the box shall be approximately 14 inches x 12 inches x 6 inches. The enclosure shall have an opaque hinged cover, with a transparent window made up of polycarbonate and a silicone gasket for sealing.

2. The control panel shall include a field adjustable switch with variable sensitivity settings for oil with a separate over-current relay and field adjustable motor overload heater with an optional automatic or manual reset button. The control panel shall have an adjustable high decibel warning horn with illuminated red light and alarm silencing switch. Separate LED indicator lights allow users to monitor: 1) oil alert, 2) high water, 3) high motor amps, 4) power to system and 5) pump activation
- H. High-Level Alarm/Redundant Run Float
1. The high-level liquid alarm shall be enabled by an additional float placed at a level in the pit above normal acceptable liquid levels. The rising of this float (closing) shall cause the controller to energize the audible alarm (where applicable), remote alarm relay (dry contacts), and the high-level LED. The high-level alarm shall only be de-energized after the high-level float drops to its normal state (open). The high-level liquid alarm shall not disable the pump motor from normal operation. In addition, the activation of the high-level float will also attempt to run the pump should the normal start float have become incapacitated.
- I. Silence Button
1. An external control mounted silence alarm button shall be provided to de-energize the audible alarm for the convenience of maintenance personnel. Depressing this button shall not clear any fault, but shall silence the alarm for 5 minutes. If a fault is removed and returns, the audible alarm shall reenergize as expected.
  2. Pump Floats and Probe Submersible pump shall be pump factory fitted with a Vertical float(s) and probe. The probe and floats shall be an integral unit constructed of 304 stainless steel. Each float shall activate an internal reed switch capable of handling the Oil Minder circuit sensing voltages. Float switches shall be in the normally open position. Rising liquid shall cause each float ball (pump run and high level) to rise ½” and close the respective circuit. The integral probe shall sense for conductivity through the media being pumped. Wire shall be 18-4 AWG with SJOOW insulation. Standard length shall be 16’.
- J. Self-Diagnostic
1. The control shall include a “push to test” feature for all pump and control diagnostic functions. This test helps ensure the system is installed properly and remains in working order.
  2. Oil Detection The oil sensor probe voltage shall not exceed 15 millivolts DC until it comes in contact with water, at which point the oil sensor returns to 5 VDC.
- K. Installation
1. The pump system shall be supplied as a factory assembled system. The system shall physically fit and be fully functional with all on-off and oil detection features along with all alarms within a 24 inches X 24 inches X 24 inches deep sump, allowing adequate operational space for a required grate or pit cover.
  2. Capacity See drawing schedule sheet
  3. Warranty See part 1
- L. Basis of Design **Stancor Model SE-50-ELV** complete pump and Oil-Minder® control system for each elevator pit, as shown on the drawings

## **PART 3 - EXECUTION**

### **3.1 EARTHWORK**

- A. Excavation and filling are specified in Division 31.

### **3.2 EXAMINATION**

- A. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

### **3.3 INSTALLATION**

- A. Pump Installation Standards:
  - 1. Comply with HI 1.4 for installation of centrifugal pumps.
  - 2. Comply with HI 3.1-3.5 for installation of progressing-cavity sewage pumps.
- B. Equipment Mounting:
  - 1. Install progressing-cavity sewage pumps on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 03.
  - 2. Comply with requirements for vibration isolation and seismic control devices specified in Division 22.
  - 3. Comply with requirements for vibration isolation devices specified in Division 22.
- C. Wiring Method: Comply with requirements in Division 26.
- D. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

### **3.4 CONNECTIONS**

- A. Comply with requirements for piping specified in Division 22. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

### **3.5 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.
- B. Perform tests and inspections.
  - 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.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection.
  - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Pumps and controls will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

### **3.6 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform and perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Assure all control wiring and power service wiring is connected and functional.

### **3.7 ADJUSTING**

- A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.
- B. Adjust control set points.

### **3.8 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train. Owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

**END OF SECTION**

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## **SECTION 22 14 23 - STORM DRAINAGE PIPING SPECIALTIES**

### **PART 1 - GENERAL**

#### **1.1 GENERAL**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Metal roof drains.
  - 2. Miscellaneous storm drainage piping specialties.
  - 3. Cleanouts.
  - 4. Through-penetration firestop assemblies.
  - 5. Flashing materials.

#### **1.3 ACTION SUBMITTALS**

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

#### **1.4 QUALITY ASSURANCE**

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

### **PART 2 - PRODUCTS**

#### **2.1 METAL ROOF DRAINS**

- A. Cast-Iron, Large-Sump, Roof Drain and Overflow Drain
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Josam Company.
    - b. MIFAB, Inc.
    - c. Smith, Jay R. Mfg. Co.
    - d. Watts; a Watts Water Technologies company.
    - e. Or approved equivalent.
  - 2. Standard: ASME A112.6.4, for general-purpose roof drains.
  - 3. Body Material: Cast iron.
  - 4. Combination Flashing Ring and Gravel Stop:

5. Under deck Clamp:
6. Expansion Joint:
7. 3 inch High Standpipe on Overflow Drain

## 2.2 CLEANOUTS

### A. Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Josam Company.
  - b. Sioux Chief Manufacturing Company, Inc.
  - c. Smith, Jay R. Mfg. Co.
  - d. Watts; a Watts Water Technologies company.
  - e. Or approved equivalent.
2. Standard: ASME A112.36.2M, for adjustable housing cleanouts.
3. Size: Same as connected branch.
4. Body or Ferrule Material: Stainless steel
5. Clamping Device: match pipe material
6. Closure: Brass plug with tapered threads.
7. Adjustable Housing Material: Cast iron with threads set-screws or other device.
8. Frame and Cover Material and Finish: Nickel-bronze, copper alloy or Stainless steel.
9. Frame and Cover Shape: Square.
10. Top-Loading Classification: Heavy Duty.

### B. Test Tees:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Josam Company.
  - b. MIFAB, Inc.
  - c. Smith, Jay R. Mfg. Co.
  - d. Watts; a Watts Water Technologies company.
  - e. Or approved equivalent.
2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
3. Size: Same as connected drainage piping.
4. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure Plug: Countersunk.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

### C. Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - a. Josam Company.
  - b. MIFAB, Inc.
  - c. Smith, Jay R. Mfg. Co.
  - d. Watts; a Watts Water Technologies company.
  - e. Or approved equivalent.
2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
3. Size: Same as connected drainage piping.
4. Body Material: T-branch as required to match connected piping.
5. Closure: Drilled and threaded brass plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Square, nickel-bronze, copper-alloy, or stainless-steel wall-installation frame and cover.

## **2.3 FLASHING MATERIALS**

- A. Copper Sheet: ASTM B 152/B 152M, 12 oz. /sf
- B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.
- C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.
- D. Fasteners: Metal compatible with material and substrate being fastened.
- E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.
- F. Solder: ASTM B 32, lead-free alloy.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions.
  1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
  2. Install expansion joints, if indicated, in roof drain outlets.
  3. Position roof drains for easy access and maintenance.
- B. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.



- C. Install cleanouts in aboveground piping and building drain piping according to the following instructions unless otherwise indicated:
  1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
  2. Locate cleanouts at each change in direction of piping greater than 45 degrees.
  3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
  4. Locate cleanouts at base of each vertical soil and waste stack.
- D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- F. Install test tees in vertical conductors and near floor.
- G. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.
- H. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

### **3.2 CONNECTIONS**

- A. Comply with requirements for piping specified in Division 22. Drawings indicate general arrangement of piping, fittings, and specialties.

### **3.3 FLASHING INSTALLATION**

- A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
  1. Copper Sheets: Solder joints of copper sheets.
- B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
  1. Pipe Flashing: Sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
  2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
  3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
- C. Set flashing on floors and roofs in solid coating of bituminous cement.
- D. Secure flashing into sleeve and specialty clamping ring or device.
- E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

### **3.4 PROTECTION**

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

**END OF SECTION 22 14 23**

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## **SECTION 22 33 00 - ELECTRIC, WATER HEATERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Commercial, electric, storage, water heaters.
  - 2. Commercial, electric, small to mid capacity water heaters
  - 3. Residential, electric, storage, water heaters.
  - 4. Commercial electric instantaneous water heaters
  - 5. Small Space Point of Use Water Heater
  - 6. Ceiling Hung Horizontal Water Heater
  - 7. Water heater accessories.
  - 8. Floor leak detection
  - 9. Source quality control

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
  - 1. Wiring Diagrams: For power, signal, and control wiring.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Seismic Qualification Certificates: For commercial water heaters, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity 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.
- B. Product Certificates: For each type of commercial residential and tankless, electric, water heater, from manufacturer.
- C. Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Warranty: Sample of special warranty.

### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For electric, water heaters to include in emergency, operation, and maintenance manuals.

### **1.6 QUALITY ASSURANCE**

- A. 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.
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects."

### **1.7 COORDINATION**

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

### **1.8 WARRANTY**

- A. General: periods are stipulated here for this specification section. Generally manufacturers standard warranty applies, however, longer warranty periods, if required, are stipulated in part 2 where each product is specified. The warranty periods stipulated in part 2 take priority over standard manufacturer's warranty periods specified in part 1.
- B. Warranty: Manufacturer's standard warranty – submit a form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within manufacturers standard specified warranty period. Manufacturers standard warranty must include minimum durations below
- C. Minimum Durations and Special Warrantees: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.
  - 1. Structural failures including shell.
  - 2. Warranty period shall begin on the date of project substantial completion stipulated by the Architect and/or the Construction Manager
  - 3. Commercial, Electric, Storage, Water Heaters:
    - a. Storage Tank: Five years.
    - b. Controls and Other Components: Three years.
  - 4. Compression Tanks: Five years.

## **PART 2 - PRODUCTS**

### **2.1 COMMERCIAL, ELECTRIC WATER HEATERS: EWH-1**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
  - 1. Hubbell Water Heaters
  - 2. Lochinvar, LLC.
  - 3. Rheem Manufacturing Company.
  - 4. Smith, A. O. Corporation.
  - 5. Or approved equivalent.
  
- B. Standard: UL 174.
  
- C. Storage-Tank Construction: Steel
  
- D. Interior Finish: manufacturers standard on a par with seamless hydrastone cement
  
- E. Tappings: ASME B1.20.1 pipe thread.
  
- F. Pressure Rating: 150 psig 1035 kPa.
  
- G. Each heater tank shall be fitted with non-ferrous solid copper-silicon threaded connections for maximum corrosion resistance.
  
- H. Insulation: Insulation to be a minimum 2 inch thick polyurethane foam which will exceed ASHRAE/IESNA 90.1 standard for heat loss. Models shall meet the standby loss requirements of the U.S. Department of energy and current edition of ASHRAE/IESNA 90.1.
  
- I. Jacket: High impact composite that does not rust or corrode.
  
- J. Anode Rods: Not required for cement lined steel tanks.
  
- K. Factory-Installed Storage-Tank Appurtenances:
  
- L. Drain Valve: ASSE 1005 if tank has drain outlet. Provide hose-end drain valve in piping for water heaters without drain outlet. Comply with requirements for hose-end drain valves specified in Division 22.
  
- M. Heating Element: Heating elements shall be immersion bolt on type, incoloy sheathed.
  
- N. Magnetic contactor(s) are heavy duty resistive load type rated for 200,000 cycles.
  
- O. Safety Control: High-temperature-limit cutoff device or system.
  
- P. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
  
- Q. Temperature Control: Adjustable thermostat, to setting of at least 170 deg F.
  
- R. Warranty: Manufacturer shall warranty all electrical components against defects in workmanship and material for a period of one (1) year from date of start-up and the pressure vessel for a full five (5) years Non Pro-Rated (Optional Specification: full ten (10) years Non Pro-Rated) from date of

start-up, provided that the unit is started within three (3) months of date of shipment and installed and operated within the scope of the tank design and operating capability. Each water heater shall be shipped with a complete set of installation and operating instructions including spare parts list and approved drawing.

1. Basis of Design

S. A. O. Smith Dura-Power™ Model(s) or approved equivalent.

1. See Drawings for additional information

## 2.2 WATER HEATER ACCESSORIES

A. Water Compression Tanks

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- a. AMTROL, Inc.
- b. Smith, A. O. Corporation.
- c. State Industries.
- d. Taco, Inc.

2. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air pre-charge to minimum system-operating pressure at tank.

B. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.

C. Interior Finish: Comply with NSF 61 Annex G barrier materials for potable water tank linings, including extending finish into and through tank fittings and outlets.

D. Air-Charging Valve: Factory installed.

E. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of water heater, and include drain outlet not less than NPS 3/4 DN 20 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

F. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE / IESNA 90.1 or ASHRAE 90.2.

G. Heat-Trap Fittings: ASHRAE 90.2.

H. Manifold Kits: water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each water heater and calibrated memory-stop balancing valves with integral flow meters to provide balanced flow through each water heater.

I. Comply with requirements for ball, butterfly, or gate type shutoff valves specified in for Plumbing Piping," Pressure-Reducing Valves: ASSE 1003 for water. Set at 25 psig 172.5-kPa-maximum outlet pressure unless otherwise indicated.

J. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

K. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than water heater working-pressure rating.

L. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.

M. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.

- N. Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches 457 mm above the floor.
- O. Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting water heater and water.

**2.3 SOURCE QUALITY CONTROL**

- A. Factory Tests: Test and inspect water heaters specified to be ASME code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 for retesting and re-inspecting requirements and Division 01 for requirements for correcting the Work.
- D. Prepare test and inspection reports.

**PART 3 - EXECUTION**

**3.1 INDEX OF ELECTRIC WATER HEATERS**

	Type	Application	Tag #
1.	Commercial Electric, water Heater.	SIMILAR TO COMMERCIAL 30 - 80 GALLON WATER Commercial Electric tank type appropriate for area use, or remote toilet core, etc.	EWH-1

**3.2 WATER HEATER INSTALLATION**

- A. Commercial, Electric, water Heater Mounting: Install commercial, electric, water heaters on concrete base. Comply with requirements for concrete bases specified in Division 03.
  - 1. Exception: Omit concrete bases for commercial, electric, water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
  - 2. Maintain manufacturer's recommended clearances.
  - 3. Arrange units so controls and devices that require servicing are accessible.
  - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch 450-mm centers around the full perimeter of concrete base.
  - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 8. Anchor water heaters to substrate.

**3.3 CONNECTIONS**

- A. Comply with requirements for piping specified in water piping sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Where installing piping adjacent to electric, water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of water heaters.

### **3.4 IDENTIFICATION**

- A. Identify system components. Comply with requirements for identification specified in Division 22.

### **3.5 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
  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.
  2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
  4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Electric, water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 for retesting and re-inspecting requirements and Division 01 for requirements for correcting the Work.
- C. Prepare test and inspection reports.

### **3.6 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train. Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, water heaters.

**END OF SECTION**

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## **SECTION 22 42 00 - COMMERCIAL PLUMBING FIXTURES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Plumbing fixtures
  - 2. Toilet seats
  - 3. Supply fittings
  - 4. Risers
  - 5. Water tempering equipment
  - 6. Source quality control
  - 7. Grout

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

#### **1.5 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no less than one of each type.

## **PART 2 - PRODUCTS**

### **2.1 PLUMBING FIXTURES**

- A. Plumbing Fixtures Are Scheduled On The Drawings. See Drawings For Exact Types.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. American Standard America.
    - b. Elkay Manufacturing Company.
    - c. Just Manufacturing.
    - d. Kohler Co.
    - e. TOTO USA, INC.
    - f. Sloan Valve Company.
    - g. Or approved equivalent.
  2. All plumbing fixture are to be high quality grade 1 fixtures.
  3. All plumbing fixtures shall be furnished from the same manufacturer.
  4. All fixtures shall comply with the latest water conservation standards.
- B. Plumbing Fixtures And Trim
1. Refer to Architectural and Plumbing Drawings for quantities, locations and mounting heights of fixtures provided under this Section.
  2. Fixture trim, traps, faucets, escutcheons and waste pipes exposed to view in finished spaces shall be IPS brass with polished chromium plating (CP) over nickel finish.
  3. Vitreous china fixtures shall be regular selection fused and vitrified to produce homogeneous material with close grain without pores. Surfaces that contact walls, floors and other fixtures shall be set true.
  4. Enameled surfaces on cast iron fixtures shall be of suitable thickness to provide the highest commercial grade. Exterior exposed surfaces not enameled shall be treated at factory with one coat of filler.
  5. Affix manufacturer's guarantee label or trademark to fixture to indicate first quality. Acid-resisting enameled fixture shall bear manufacturer's symbol signifying resistance to acid.
  6. Set fixtures with wall outlet flanges at proper distance from floors and walls with closet setting compound or gasket.
  7. Vitreous china and enameled cast-iron fixtures shall be white throughout unless specified otherwise. Closet seats shall match closet fixture color.

### **2.2 TOILET SEATS**

- A. Toilet Seats :
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. American Standard America.

- b. Bemis Manufacturing Company.
  - c. Church Seats; Bemis Manufacturing Company.
  - d. Kohler Co.
  - e. Olsonite Seat Co.
  - f. TOTO USA, INC.
  - g. Or approved equivalent.
2. Standard: IAPMO/ANSI Z124.5.
  3. Material: Plastic.
  4. Type: Commercial (Heavy duty).
  5. Shape: Elongated rim, open front
  6. Hinge: Check.
  7. Hinge Material: Non-corroding metal.
  8. Seat Cover: Not required.
  9. Color: White.

### **2.3 SUPPLY FITTINGS**

- A. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Loose key.

### **2.4 RISERS**

- A. NPS 1/2 chrome-plated, soft-copper flexible tube or ASME A112.18.6, braided or corrugated stainless-steel, flexible hose waste fittings
- B. Standard: ASME A112.18.2/CSA B125.2.
- C. Drain: Grid with NPS 1-1/2 DN 40 tailpiece.
- D. Trap:
  1. Size: NPS 1-1/2.
  2. Note: All trap trim is to match the finish selected by the Architect. See architectural requirements for finish material
  3. Material: two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and finish -plated brass or steel wall flange.
  - a. Supply Connections: For hot and cold water.

## **2.5 WATER-TEMPERING EQUIPMENT**

- A. Hot- and Cold-Water, Water-Tempering Equipment,
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
    - a. Guardian Equipment Co.
    - b. Haws Corporation.
    - c. Lawler Manufacturing Company, Inc.
    - d. Powers.
    - e. Speakman Company.
    - f. Or approved equivalent.
  - 2. Description: Factory-fabricated equipment with thermostatic mixing valve.
    - a. Thermostatic Mixing Valve: Designed to provide 85 deg F tepid, potable water at emergency plumbing fixtures, to maintain temperature at plus or minus 5 deg F throughout required 15-minute test period, and in case of unit failure to continue cold-water flow, with union connections, controls, metal piping, and corrosion-resistant enclosure.
    - b. Supply Connections: For hot and cold water.

## **2.6 SOURCE QUALITY CONTROL**

- A. Certify performance of emergency plumbing fixtures by independent testing organization acceptable to authorities having jurisdiction.

## **2.7 GROUT**

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Non-shrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.
- B. Examine walls and floors for suitable conditions where closet plumbing fixtures will be installed.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

#### A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.
3. Install toilet seats on water closets.

#### B. Urinal Installation:

1. Install urinals level and plumb according to roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
3. Install Wall-hung, bottom-outlet urinals with tubular waste piping attached to supports.
4. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.
5. Install trap-seal liquid in waterless urinals.

#### C. Lavatory Installation:

1. Install lavatories level and plumb according to roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-mounted lavatories.

#### D. Sink Installation:

1. Install sinks level and plumb according to roughing-in drawings.
2. Install supports, affixed to building substrate, for wall-hung sinks.
3. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
4. Set floor-mounted sinks in leveling bed of cement grout.

- E. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07.

#### F. Flushometer-Valve Installation:

1. Install flushometer-valve water-supply fitting on each supply to each urinal.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible urinals with handle mounted on open side of compartment.
4. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

#### G. Support Installation:

1. Install supports, affixed to building substrate, for wall-hung urinals.
2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
3. Use carriers without waste fitting for urinals with tubular waste piping.
4. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.
5. Install supports, affixed to building substrate, for floor-mounted, back-outlet water closets.
6. Use carrier supports with waste-fitting assembly and seal.
7. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.

- H. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.
- I. Water Cooler Installation:
  - 1. Install fixtures level and plumb according to roughing-in drawings. For fixtures indicated for children, install at height required by authorities having jurisdiction.
  - 2. Set freestanding pressure water coolers on floor.
  - 3. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.
  - 4. Install mounting frames, affixed to building construction, and attach recessed, pressure water coolers to mounting frames.
  - 5. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball or gate valve. Install valves in locations where they can be easily reached for operation.
  - 6. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- J. Flushometer-Valve Installation:
  - 1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
  - 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
  - 3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
  - 4. Install actuators in locations that are easy for people with disabilities to reach.
  - 5. Install fresh batteries in battery-powered, electronic-sensor mechanisms.
- K. Wall Flange and Escutcheon Installation:
  - 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
  - 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
  - 3. Comply with escutcheon requirements specified in Division 22.
- L. Joint Sealing:
  - 1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
  - 2. Match sealant color to water-closet color.
  - 3. Comply with sealant requirements specified in Division 07.

### **3.3 CONNECTIONS**

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Where installing piping adjacent to water closets, allow space for service and maintenance.

### **3.4 ADJUSTING**

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
- C. Adjust water pressure at flushometer valves to produce proper flow.

- D. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

### **3.5 CLEANING AND PROTECTION**

- A. Clean all plumbing fixtures and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for fixtures and fittings.
- C. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner

**END OF SECTION 22 42 00**

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FIXTURES.DOC**

## SECTION 23 05 00 - COMMON WORK RESULTS FOR HVAC

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20, Common Mechanical and Electrical Requirements. To avoid repetition, they are not repeated in each relevant Section. These requirements are applicable to the work of this Division, and are hereby incorporated by reference.

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Transition fittings.
  - 3. Dielectric fittings.
  - 4. Mechanical sleeve seals.
  - 5. Sleeves.
  - 6. Escutcheons.
  - 7. Grout.
  - 8. Equipment installation requirements common to equipment sections.
  - 9. Painting and finishing.
  - 10. Concrete bases.
  - 11. Supports and anchorages.
  - 12. Containment Room Sealing Requirements.
  - 13. Rated fire penetration sealants.
  - 14. Material and workmanship.
  - 15. Access panels.

#### 1.3 REFERENCES

- A. Publications listed below (including amendments, addenda, revisions, supplements, and errata) form part of this specification to the extent referenced. Publications are referenced in the text by the basic designations only.
  - 1. American Iron and Steel Institute (ASI)
  - 2. National Fire Protection Association (NFPA)
    - a. NFPA 70                      National Electric Code
  - 3. American Society for Testing and Materials (ASTM)
    - a. ASTM A36 Standard Specification for Carbon Structural Steel
    - b. ASTM A53                      Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
    - c. ASTM A109                      Standard Specification for Steel, Strip, Carbon (0.25 Maximum Percent), Cold-Rolled



- d. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
  - e. ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications
  - f. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
  - g. ASTM A501 Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing
  - h. ASTM A633 Standard Specification for Normalized High-Strength Low-Alloy Structural Steel Plates
  - i. ASTM A635 Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Carbon, Commercial Steel, Drawing Steel, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, Hot-Rolled
  - j. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  - k. ASTM A682 Standard Specification for Steel, Strip, High-Carbon, Cold-Rolled
  - l. ASTM A924 Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process
  - m. ASTM A1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability
  - n. ASTM A1018 Standard Specification for Steel, Sheet and Strip, Heavy Thickness Coils, Hot Rolled, Carbon, Structural, High-Strength Low-Alloy, Columbium or Vanadium, and High-Strength Low-Alloy with Improved Formability
  - o. ASTM B117 Standard Practice for Operating Salt Spray (Fog) Apparatus
  - p. ASTM B633 Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel
  - q. ASTM C920 Standard Specification for Elastomeric Joint Sealants
  - r. ASTM C1193 Standard Guide for Use of Joint Sealants
  - s. ASTM D522 Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings
  - t. ASTM D523 Standard Test Method for Specular Gloss
  - u. ASTM D610 Standard Test Method for Evaluating Degree of Rusting on Painted Steel Surfaces.
  - v. ASTM D2247 Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity
  - w. ASTM D3451 Standard Guide for Testing Coating Powders and Powder Coatings
  - x. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
  - y. ASTM F1136 Standard Specification for Chromium/Zinc Corrosion Protective Coatings for Fasteners
4. American Welding Society (AWS)
  5. Code of Federal Regulations (CFR)
  6. Metal Framing Manufacturers Association (MFMA)
    - a. MFMA Metal Framing Standards Publication
  7. Underwriters Laboratories (UL)
    - a. UL 723 Test for Surface Burning Characteristics of Building Materials

## 1.4 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
  - 1. CPVC: Chlorinated polyvinyl chloride plastic.
  - 2. PE: Polyethylene plastic.
  - 3. PVC: Polyvinyl chloride plastic.
- G. The following are industry abbreviations for rubber materials:
  - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
  - 2. NBR: Acrylonitrile-butadiene rubber.

## 1.5 SUBMITTALS

- A. Product Data: For the following:
  - 1. Transition fittings.
  - 2. Dielectric fittings.
  - 3. Mechanical sleeve seals.
  - 4. Escutcheons.
  - 5. Containment room sealants.
  - 6. Rated fire penetration sealants.
- B. Welding certificates.

## 1.6 QUALITY ASSURANCE

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."
- B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

- C. Align components. No strain shall be placed on weld during welding. No part of pipe shall be offset more than 20 percent of thickness. Set flanges and branches properly.
- D. Weld only by approved acetylene or electric welding processes. All welders shall hold certificate from approved insurance company.
- E. Conduct test to demonstrate suitability of procedures to be used in making welds that conform to specified requirements.
- F. Welder Qualification:
  - 1. Test welders to demonstrate ability to make acceptable welds. Tests conducted for qualification of welder for work under one Division or Section shall not qualify welder for work under another Division or Section.
  - 2. Tests shall be as prescribed for welder qualification in Section IX of the ASME code.
  - 3. Records of tests shall be as follows: Each welder shall be assigned an identifying number, letter or symbol. Identifying mark shall be stamped adjacent to welds made by this welder. Identification shall be at top of horizontal piping and at front of vertical piping.
  - 4. Maintain record of welders employed, showing dates and results of tests and identifying mark assigned to each welder. Certify records and make them accessible to Owner's project representative and/or project manager. Before completion of project, one copy of records
  - 5. No qualification shall be older than three years when welder commences work on this project. If welder has not welded in required welding process for a period of six months, he shall be re-certified.
- G. Welding Tests
  - 1. As designated by Architect, remove welds for destructive testing or for testing by non-destructive means. Tests shall be as determined by Architect.
  - 2. If, in Architect's opinion, welds so tested do not meet requirements of Sections VIII and IX of ASME, then the contractor shall pay for the costs of the tests. Remove welds welded by that welder, at no cost to the Owner. Rewelding shall be performed by qualified welder other than welder whose welds did not pass test. Welders whose welds were defective shall not be employed on site for remainder of project.
  - 3. Welding of stanchions, brackets, anchors and other welding not performed on pipe joints shall be in accordance with requirements of AWS specifications and requirements.
- H. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

## **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.
- C. Protect and cover equipment (VAV boxes, coils, fans, pumps, control valves, etc) and ductwork components with plastic when stored on site to prevent entrance of dirt, debris and moisture.

## **1.8 COORDINATION**

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.
- C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. In other Part 2 articles where subparagraph 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 the manufacturers specified or approved equivalent.
  - 2. Proprietary Manufacturers: Provide products by the manufacturers specified.

### **2.2 PIPE, TUBE, AND FITTINGS**

- A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### **2.3 JOINING MATERIALS**

- A. Refer to individual Division 23 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8 inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
  - 2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

- E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.
- G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- H. Solvent Cements for Joining Plastic Piping:
  - 1. CPVC Piping: ASTM F 493.
  - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
- I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

## 2.4 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings: CPVC and PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
  - 1. Basis of Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
    - a. Eslon Thermoplastics.
- B. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
  - 1. Basis of Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
    - a. Thompson Plastics, Inc.
- C. Plastic-to-Metal Transition Unions: MSS SP-107, CPVC and PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
  - 1. Basis of Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
    - a. NIBCO INC.
    - b. NIBCO, Inc.; Chemtrol Div.

## 2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).

1. Basis of Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
  - a. Capitol Manufacturing Co.
  - b. Central Plastics Company.
  - c. Eclipse, Inc.
  - d. Epco Sales, Inc.
  - e. Hart Industries, International, Inc.
  - f. Watts Industries, Inc.; Water Products Div.
  - g. Zurn Industries, Inc.; Wilkins Div.
  
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
  1. Basis of Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
    - a. Capitol Manufacturing Co.
    - b. Central Plastics Company.
    - c. Epco Sales, Inc.
    - d. Watts Industries, Inc.; Water Products Div.
  
- E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
  1. Basis of Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Central Plastics Company.
    - d. Pipeline Seal and Insulator, Inc.
    - e. Thunderline
  
  2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.
  
- F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
  1. Basis of Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
    - a. Calpico, Inc.
    - b. Lochinvar Corp.
  
- G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
  1. Basis of Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
    - a. Perfection Corp.
    - b. Precision Plumbing Products, Inc.
    - c. Sioux Chief Manufacturing Co., Inc.
    - d. Victaulic Co. of America.

## 2.6 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
  - 1. Basis of Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Metraflex Co.
    - d. Pipeline Seal and Insulator, Inc.
    - e. Thunderline
  - 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 3. Pressure Plates: Plastic. Include two for each sealing element.
  - 4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating or Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## 2.7 SLEEVES

- A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- C. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with set screws.

## 2.8 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
  - 1. Finish: Polished chrome-plated
- D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
  - 1. Finish: Polished chrome-plated
- E. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.
- F. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw, and chrome-plated finish.
- G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

- H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

## **2.9 GROUT**

- A. Description: ASTM C 1107, Grade B, non-shrink and nonmetallic, dry hydraulic-cement grout.
  - 1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
  - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
  - 3. Packaging: Premixed and factory packaged.

## **2.10 RATED FIRE PENETRATION SEALANTS**

- A. Submit 3M, Hilti or Firespec sealants for approval prior to use.
- B. Sealants, caulking and devices shall be rated the same as the wall rating they are used in.

## **2.11 ACCESS PANELS**

- A. Description: Interior construction access panels.
  - 1. Basis of Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
    - a. Milcor
    - b. Knapp
    - c. Nystorm
    - d. Inland Steel
- B. Coordinate selection with other Divisions supplying similar access panels.
- C. Access panels shall have same fire rating classification as surface penetrated.

## **PART 3 - EXECUTION**

### **3.1 PIPING SYSTEMS - COMMON REQUIREMENTS**

- A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.



- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping at indicated slopes as specified in other Division 23 sections.
- H. Install piping free of sags and bends.
- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
  - 1. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
  - 2. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
  - 3. Insulated Piping: One-piece, stamped-steel type .
  - 4. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
  - 5. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece or split-casting, cast-brass type with polished chrome-plated finish.
  - 6. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type
  - 7. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
  - 8. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

### **3.2 PENETRATIONS AND SLEEVES**

#### **A. General**

- 1. Lay out penetration and sleeve openings in advance, to permit provision in work. Coordinate work carefully with architectural and structural work. Set sleeves and conduit in forms before concrete is poured. Provide remedial work where sleeves and conduits are omitted or improperly placed. Remedial work includes core drilling (see requirements below) for penetrations if walls are poured, or otherwise constructed, without required sleeves. Provide core drilling (see requirements below) of existing construction. Do not penetrate structural members without Structural Engineer's/Architect's written approval.
- 2. Provide sleeves and packing materials at penetrations of foundations, walls, basement floors, slabs (except on-grade), partitions and floors. Sleeve installation shall meet NFPA-101 requirements, UL rated assemblies requirements, and materials requirements of these specifications. Submit a list of the UL listed details that the Contractor intends on using on this project in all rated assemblies.
- 3. Sleeves that penetrate outside walls, basement slabs, footings and beams shall be waterproof. Sleeves that penetrate floors shall be fireproof and waterproof.
- 4. Sleeves for insulated pipe and duct in non-fire rated construction shall accommodate continuous insulation without compression. Sleeves and/or penetrations in fire rated construction that do not require fire dampers shall be packed with fire rated material that shall maintain the fire rating of the wall. Seal ends of penetrations to provide continuous vapor barrier where insulation is interrupted. Where fire dampers are required, install sleeve and damper assembly in accordance with damper listing.
- 5. Where pipes passing through openings are exposed in finished rooms, finishes of filling materials shall match and be flush with adjoining floor, ceiling, and wall finishes.
- 6. Identify unused sleeves and slots for future installation. Fill slots, sleeves and other openings in floors or walls if not used. Fill spaces in openings after installation of pipe, duct, conduit or cable. Fill for floor penetrations shall prevent passage of water, smoke, fire, and fumes. Fill

- shall be fire resistant in fire floors and walls, and shall prevent passage of air, smoke and fumes.
7. Do not support piping risers or conduit on sleeves.
  8. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7, Through-Penetration Firestop Systems for materials.
  9. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements. Verify final equipment locations for roughing-in.
  10. Installation Testing, Listings and Approvals
    - a. Installation of sleeves, fill and packing shall meet material manufacturer's recommendations exactly, particularly as regards safety, ventilation, removal of foreign materials and other details of installation. Dam openings as recommended. Remove flammable materials used for damming and forming seals in fire-rated construction.
    - b. Sleeve penetration methods shall be water- and gas-tight and shall meet requirements of ASTM E-119 Standard Methods of Fire Tests of Building Construction and Materials.
    - c. Fire-stop penetration seal methods and materials shall be FM-approved and UL-listed as applicable. They shall have the same rating as the structure penetrated. Submit manufacturer's detail sheet indicating assembly rating.
      - 1) Inspect foamed sealants to ensure manufacturer's optimum cell structure and color ranges.
- B. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs. Sleeves are not required for slab-on-grade floors unless specified otherwise. Sleeves are required for core-drilled holes on any floor.
1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
  3. Install sleeves that are large enough to provide 1/4 inch (6.4 mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - a. Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
    - b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
    - c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07, Sheet Metal Flashing and Trim for flashing.
      - 1) Seal space outside of sleeve fittings with grout.
  4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07, Joint Sealants for materials and installation.
- C. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1 inch (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
  3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- D. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1 inch (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- E. Duct Sleeves and Prepared Openings
1. Provide galvanized-steel sheet duct sleeves for round ducts 15" and smaller. Provide prepared, framed openings for round ducts larger than 15" and for square, rectangular and flat oval ducts, except as specified otherwise. Sleeves shall meet SMACNA requirements.
  2. Provide galvanized-steel sheet duct sleeves for ducts through 1-, 2- or 3-hour fire-rated construction and smoke partitions, regardless of size and shape of ducts. Sleeves shall maintain fire rating of construction penetrated. Sleeve and seal materials, construction and clearances shall meet requirements of SMACNA Fire Damper and Heat Stop Guide for Air Handling Systems.
  3. Prepared openings shall be framed to provide 1" clearance between framing and duct or duct insulation.
  4. Provide 4 inches (100 mm) wide 20 gauge galvanized sheet metal collars at sleeves and prepared openings, sized to cover entire duct penetration including sleeve and seal, and to accommodate duct and insulation as necessary. Edges shall have milled lips ground smooth. Paint to match finish of duct or as directed by Architect.
  5. All duct penetrations through concrete floors in mechanical rooms shall be provided with 2 inches (50 mm) high water stopped curbs surrounding the openings. This applies to mechanical rooms located above the lowest floor level.
- F. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07, Penetration Firestopping for materials.
- G. Verify final equipment locations for roughing-in.
- H. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### **3.3 CORE DRILLING**

- A. Core drilling shall be avoided in new construction. Set sleeves prior to installation of structure for passage of pipes, conduit and ducts. Where core drilling is unavoidable (e.g. when individual sleeves are not installed or incorrectly located) or required by renovation projects, locate required openings prior to coring and submit locations for review.
- B. Coordinate openings with other Divisions.
- C. Do not disturb existing systems. Protect areas from damage.
- D. Thoroughly investigate existing conditions in vicinity of required opening prior to coring.

### 3.4 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Braze Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - 3. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
  - 4. PVC Nonpressure Piping: Join according to ASTM D 2855.
- J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.
- K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.
- L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
  - 1. Plain-End Pipe and Fittings: Use butt fusion.
  - 2. Plain-End Pipe and Socket Fittings: Use socket fusion.
- M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

### **3.5 PIPING CONNECTIONS**

- A. Make connections according to the following, unless otherwise indicated:
  - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
  - 3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
  - 4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

### **3.6 EXPANSION PROVISIONS**

- A. Installation of piping must allow for expansion using offsets or loops, as necessary to prevent undue strain. Takeoffs from mains to runouts shall not have less than three-elbow swing.
- B. Mains and risers with loops or offsets shall be securely anchored to structure so as to impart expansion towards loops or offsets. Anchors shall be constructed of heavy forged wrought iron, secured to pipe and to structure. Provide vibration isolation as required.
- C. Provide pipe alignment guides as required to guide expanding pipe to move freely from anchor points toward expansion joints, offsets, etc.

### **3.7 ANCHORS AND INSERTS**

- A. Inserts shall be iron or steel of type to receive machine bolt head or nut after installation. Inserts shall permit adjustment of bolt in one horizontal direction and shall develop strength of bolt when installed in properly cured concrete.
- B. Provide anchors for attachment of equipment supports and hangers.

### **3.8 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS**

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- D. Install equipment to allow right of way for piping installed at required slope.
- E. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways, to satisfaction of Architect and in accordance with code requirements.
- F. Distribute equipment loads on building structural members provided for equipment support. Roof-mounted equipment shall be installed and supported on structural steel.

- G. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs for floor, wall or ceiling mounting of equipment.
- H. Provide steel supports and hardware for proper installation of hangers, anchors and guides.
- I. Provide cuts, weights, and other pertinent data required for proper coordination of equipment support provisions and installation.
- J. Structural steel and hardware shall conform to Standard Specifications of ASTM; use of steel and hardware shall conform to requirements of Section Five of Code of Practice of American Institute of Steel Construction.
- K. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly that shall void warrantee. Report in writing to Architect, prior to purchase or shipment of equipment involved, on conditions that may prevent proper installation.
- L. For all equipment installed external to the building; whether on roofs, supports, grade, etc., the installation shall comply with wind loading and impact requirements of the applicable codes for this project site. All equipment provided for this project shall be certified by the manufacturer that the equipment meets the applicable seismic, wind, earthquake, and hurricane impact requirements as set forth by the Authority Having Jurisdiction.

### **3.9 PAINTING**

- A. Painting of HVAC systems, equipment, and components is specified in Division 09, Interior Painting and Exterior Painting.
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.
- C. Equipment installed shall have shop coat of non-lead gray paint. Hangers and supports shall have one coat of non-lead red primer. Machinery (e.g. pumps, fans and air handling units) shall be stenciled with equipment name. Stencil shall be at least 6" high for large equipment, 2 inches (50 mm) high for small equipment.
- D. Note requirement for Architect's approval invoked under paragraph MATERIALS AND WORKMANSHIP regarding finish of material and equipment that is visible or subject to corrosive or atmospheric conditions.

### **3.10 CONCRETE PADS**

- A. Concrete Pads: Anchor equipment to concrete pad according to equipment manufacturer's written instructions and according to seismic codes at Project. *Provide pads for chillers, expansion tanks, glycol storage tank, steam generator, heat exchangers, steam condensate pump, chilled water pumps, hot water pumps, both air handling units, and other floor mounted equipment. Both air handling unit pads shall be at least 6" tall. All other pads shall be at least 4" tall.*
  - 1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
  - 2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18 inch (450 mm) centers around the full perimeter of the base.
  - 3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
  - 4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use *4000 psi (20.7 MPa) for interior pads and 5,000 psi (25.9 MPa) for exterior pads*, 28-day compressive-strength concrete and reinforcement as specified in Division 03, Cast-in-Place Concrete or Miscellaneous Cast-in-Place Concrete.

### **3.11 ERECTION OF METAL SUPPORTS AND ANCHORAGES**

- A. Refer to Division 05, Metal Fabrications for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

### **3.12 ERECTION OF WOOD SUPPORTS AND ANCHORAGES**

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor HVAC materials and equipment.
- B. Select fastener sizes that shall not penetrate members if opposite side shall be exposed to view or shall receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

### **3.13 GROUTING**

- A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- B. Clean surfaces that shall come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.

### **3.14 ACCESS AND ACCESS PANELS**

- A. Access panels are generally not shown on the drawings, but shall be provided.
- B. Provide proper access to materials and equipment that require inspection, replacement, repair or service, and coordinate their delivery with the installing Trade. If proper access cannot be provided, confer with Architect as to best method of approach for minimizing effect of reduced access that may result.

- C. Coordinate and prepare a location, size, and function schedule of access panels required to fully service equipment and deliver to a representative of the installing Trade. Furnish and install distinctively colored buttons (color as selected by Architect) in finished ceiling to identify access panels
- D. Furnish access panels for installation under other Sections where fire dampers, smoke dampers, volume dampers, smoke detectors, controls, shut-off valves, control valves, check valves, or other items installed under this Section require access and are concealed in floor, wall, furred space or above ceiling.
- E. Ceilings consisting of lay-in or removable splined tiles do not require access panels and dampers, splitters, or test hole openings above ceiling shall have location marked with thumbtack on finished ceiling panel. Location shall be noted on record drawings.
- F. Access panels shall be at least large enough to remove the component requiring access. Where individual components (e.g. control valves) requiring access are within 8 inches (200 mm) of the finished surface, panels shall be a minimum of 12 inch by 12 inch (300 mm by 300 mm). Where component is more than 8 inches (200 mm) from surface and at equipment requiring service (e.g. VAV boxes, fan boxes, fire dampers), access panels shall be a minimum of 24 inch x 24 inch (600 mm x 600 mm).

### **3.15 MATERIALS AND WORKMANSHIP**

- A. Work shall be neat and rectilinear. Ductwork, piping and conduit shall run concealed except in mechanical rooms and areas where no hung ceiling exists. Install material and equipment in accordance with manufacturers written instructions. Installation shall operate safely and without leakage, undue wear, noise, vibration, corrosion or water hammer. Work shall be properly and effectively protected, and pipe and duct openings shall be temporarily closed to prevent obstruction and damage before completion.
- B. Except as specified otherwise, material and equipment shall be new. Provide supplies, appliances and connections necessary for complete and operational installation. Provide components required or recommended by OSHA and applicable NFPA documents.
- C. Owner shall not be responsible for material and equipment before testing, commissioning, and acceptance.

**END OF SECTION 23 05 00**

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## **SECTION 23 05 13 - COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

#### **1.3 COORDINATION**

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.
  - 5. Variable-speed drive controllers.

### **PART 2 - PRODUCTS**

#### **2.1 GENERAL MOTOR REQUIREMENTS**

- A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
- B. Comply with NEMA MG 1 unless otherwise indicated.
- C. Comply with IEEE 841 for severe-duty motors.
- D. Motors under ½ HP, shall be designed for 120 V, 60 Hz, single phase, unless otherwise specified.
- E. Motors ½ HP and over shall be voltages as indicated in schedules on drawings.

#### **2.2 MOTOR CHARACTERISTICS**

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

## 2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, self ventilated, medium induction motor.
- B. All motors shall be premium efficiency type. They shall conform to NEMA Standard MG-1-12.53a and shall have their efficiencies determined in accordance with IEEE Standard 112 Method B. The NEMA nominal efficiency shall be listed on the motor nameplate.
- C. Minimum nominal efficiencies shall be as follows:

Premium Efficiency Motor Totally Enclosed Fan-Cooled (TEFC)				Premium Efficiency Motor Open Drip-Proof (ODP)			
Size HP	Speed (rpm)			Size HP	Speed (rpm)		
	1200	1800	3600		1200	1800	3600
NEMA Nominal Efficiency				NEMA Nominal Efficiency			
1	82.5	85.5	78.5	1	82.5	85.5	80.0
1.5	87.5	86.5	85.5	1.5	86.5	86.5	85.5
2	88.5	86.5	86.5	2	87.5	86.5	86.5
3	89.5	89.5	88.5	3	89.5	89.5	86.5
5	89.5	89.5	89.5	5	89.5	89.5	89.5
7.5	91.7	91.7	91.0	7.5	91.7	91.0	89.5
10	91.7	91.7	91.7	10	91.7	91.7	90.2
15	92.4	92.4	91.7	15	92.4	93.0	91.0
20	92.4	93.0	92.4	20	92.4	93.0	92.4
25	93.0	93.6	93.0	25	93.0	93.6	93.0
30	93.6	93.6	93.0	30	93.6	94.1	93.0
40	94.1	94.1	93.6	40	94.1	94.1	93.6
50	94.1	94.5	94.1	50	94.1	94.5	93.6
60	94.5	95.0	94.1	60	95.0	95.0	94.1
75	95.0	95.4	94.5	75	95.0	95.0	94.5
100	95.4	95.4	95.0	100	95.0	95.4	94.5
125	95.4	95.4	95.4	125	95.4	95.4	95.0
150	95.8	95.8	95.4	150	95.8	95.8	95.4
200+	95.8	96.2	95.8	200+	95.4	95.8	95.4

- D. Service Factor: 1.15.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Class B
- I. Insulation: Class F
- J. Code Letter Designation:
- Starting codes in first subparagraph below are adequate for most variable-torque loads encountered in HVAC applications; 15 hp is a common breakpoint in rating among manufacturers when Code F and Code G apply. Retain both subparagraphs and options unless Project conditions or equipment characteristics dictate otherwise.

2. Motors 15 HP and Larger: NEMA starting Code F or Code G.
3. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

## **2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS**

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
  1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
  2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
  3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
  4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
  5. Motors used with VFD shall have a minimum three (3) year manufacturer warranty.
- C. Thermal Protection (all polyphase motors): Comply with NEMA MG 1 requirements for thermally protected motors.
- D. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

## **2.5 SINGLE-PHASE MOTORS**

- A. Except where specified as part of terminal equipment (i.e. ECM motors in fan coil units), motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
  1. Permanent-split capacitor.
  2. Split phase.
  3. Capacitor start, inductor run.
  4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.
- F. Electronically Commutated Motors (ECM): Motors shall be an electronic commutation (EC) motor specifically designed for HVAC applications. AC induction type motors are not acceptable. Motors shall be permanently lubricated with heavy-duty ball bearings to match the load, and prewired to the specific voltage and phase. Internal motor circuitry shall convert AC power supplied to the equipment to DC power to operate the motor. Motor shall be speed controllable down to 20 percent of full speed (5:1 turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC control signal. Motor shall be a minimum of 85 percent efficient at all speeds.

## 2.6 STARTERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Rockwell Automation, Inc.; Allen-Bradley brand.
  4. Siemens Energy & Automation, Inc.
  5. Square D; a brand of Schneider Electric
  6. Cutler-Hammer
  7. Clark
  8. Arrow Hart
  9. Or approved equivalent.
- B. Furnish starters for HVAC equipment, except units served by MCC provided under Division 26 or those served by variable frequency drives. Provide control and other related wiring including interlocks. Power wiring (to panelboards, disconnect switches, starters and motors) will be provided under Division 26. Starters that are not integral to equipment will be installed and wired under Division 26, Electrical, and furnished under this Section.
- C. Starters that require interlocks or remote control shall be magnetic with HAND-OFF- AUTOMATIC switch (fast-slow-off-auto for two speed motors) in cover. Provide magnetic starters with auxiliary contacts, buttons and switches. Refer to other Division 23 sections and control drawings for interlock requirements. Starters shall be by single manufacturer.
1. Each 3-phase, 60 Hz motor shall be provided with magnetic starter with hand-off-automatic switch.
  2. Other motors shall be provided with a manual starter with ON-OFF switch.
  3. Control relay for each starter shall be for operation on 120V, single phase. Provide transformer of sufficient capacity within starter case.
  4. Provide inverse time limit overload and under voltage protection in each leg and with pilot lights.
  5. Provide red and green On-Off pilot lights.
  6. Provide nameplates with engraved white lettering to designate area and equipment served.
  7. Starters for refrigeration machines shall be furnished by unit manufacturer.
  8. Furnish for all single speed motors, 25 HP and above, 95 percent power factor correction capacitors. Capacitors shall be in NEMA enclosure of the same rating as the motor's starter.

## 2.7 DRIVES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to:
1. Allis-Chalmers
  2. Browning
  3. Woods
  4. Or approved equivalent.
- B. Drives for belted motors shall be flame retardant V-belt drives with adjustable motor sheave. Drives shall be as short as practical and shall have number of belts necessary to transmit required horsepower without undue slip or strain.

- C. Sheaves shall be balanced statically and dynamically.
- D. Hazardous exhaust drives and all drives for smoke control or pressurization fans shall be sized for 150 percent safety factor and shall be dual groove (2 belt) minimum.

**PART 3 - EXECUTION (Not Applicable)**

**END OF SECTION 23 05 13**

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## **SECTION 23 05 16 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Pipe loops and swing connections.
  - 2. Alignment guides and anchors.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
  - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
  - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
  - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Welding certificates.
- B. Product Certificates: For each type of expansion joint, from manufacturer.

#### **1.6 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For expansion joints to include in maintenance manuals.

## 1.7 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to the following or approved equivalent:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  2. ASME Boiler and Pressure Vessel Code: Section IX.

## PART 2 - PRODUCTS

### 2.1 ALIGNMENT GUIDES AND ANCHORS

- A. Alignment Guides:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. Adscoc Manufacturing LLC.
    - b. Advanced Thermal Systems, Inc.
    - c. Flex-Hose Co., Inc.
    - d. Flexicraft Industries.
    - e. Flex-Weld, Inc.
    - f. Hyspan Precision Products, Inc.
    - g. Metraflex, Inc.
    - h. Senior Flexonics Pathway.
    - i. Unisource Manufacturing, Inc.
    - j. U.S. Bellows, Inc.
  2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe.
- B. Anchor Materials:
1. Steel Shapes and Plates: ASTM A 36/A 36M.
  2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
  3. Washers: ASTM F 844, steel, plain, flat washers.
  4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
    - a. Stud: Threaded, zinc-coated carbon steel.
    - b. Expansion Plug: Zinc-coated steel.
    - c. Washer and Nut: Zinc-coated steel.
  5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
    - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
    - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
    - c. Washer and Nut: Zinc-coated steel.

## **PART 3 - EXECUTION**

### **3.1 PIPE LOOP AND SWING CONNECTION INSTALLATION**

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

### **3.2 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION**

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
  - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
  - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
  - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

**END OF SECTION 23 05 16**

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## **SECTION 23 05 17 - SLEEVES AND SLEEVE SEALS FOR HVAC PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Sleeves.
  - 2. Stack-sleeve fittings.
  - 3. Sleeve-seal systems.
  - 4. Sleeve-seal fittings.
  - 5. Grout.

#### **1.3 ACTION SUBMITTALS**

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

### **PART 2 - PRODUCTS**

#### **2.1 SLEEVES**

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- F. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

## **2.2 STACK-SLEEVE FITTINGS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - 1. Smith, Jay R. Mfg. Co.
  - 2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with setscrews.

## **2.3 SLEEVE-SEAL SYSTEMS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - 1. Advance Products & Systems, Inc.
  - 2. CALPICO, Inc.
  - 3. Metraflex Company (The).
  - 4. Pipeline Seal and Insulator, Inc.
  - 5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
  - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
  - 2. Pressure Plates: Galvanized steel.
  - 3. Connecting Bolts and Nuts: Galvanized steel of length required to secure pressure plates to sealing elements.

## **2.4 SLEEVE-SEAL FITTINGS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - 1. Presealed Systems.
- B. Description: Manufactured plastic, sleeve-type, waterstop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber waterstop collar with center opening to match piping OD.

## **2.5 GROUT**

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## **PART 3 - EXECUTION**

### **3.1 SLEEVE INSTALLATION**

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that shall have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch (25-mm) annular clear space between piping and concrete slabs and walls.
  - 1. Sleeves are not required for core-drilled holes.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
  - 1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.
  - 2. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 4 inches (50 mm) above finished floor level.
  - 3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
  - 2. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
  - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07, Joint Sealants.
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07, Penetration Firestopping.

### **3.2 STACK-SLEEVE-FITTING INSTALLATION**

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
  - 1. Install fittings that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation.
  - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07, Sheet Metal Flashing and Trim.
  - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level.
  - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07, Penetration Firestopping.

### **3.3 SLEEVE-SEAL-SYSTEM INSTALLATION**

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

### **3.4 SLEEVE-SEAL-FITTING INSTALLATION**

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

### **3.5 SLEEVE AND SLEEVE-SEAL SCHEDULE**

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
  - 1. Exterior Concrete Walls below Grade:
    - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel wall sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
    - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
  - 2. Concrete Slabs-on-Grade:
    - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
    - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch (25-mm) annular clear space between piping and sleeve for installing sleeve-seal system.
  - 3. Concrete Slabs above Grade:
    - a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
    - b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-pipe sleeves.
  - 4. Interior Partitions:

- a. Piping Smaller Than NPS 6 (DN 150): Galvanized-steel-pipe sleeves.
- b. Piping NPS 6 (DN 150) and Larger: Galvanized-steel-sheet sleeves.

**END OF SECTION 23 05 17**

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## **SECTION 23 05 18 - ESCUTCHEONS FOR HVAC PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Escutcheons.
  - 2. Floor plates.

#### **1.3 ACTION SUBMITTALS**

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

### **PART 2 - PRODUCTS**

#### **2.1 ESCUTCHEONS**

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

#### **2.2 FLOOR PLATES**

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping:

- a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
  - b. Insulated Piping: One-piece, stamped-steel type.
  - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
  - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
  - e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
  - f. Bare Piping in Equipment Rooms: One-piece, cast-brass type with rough-brass finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- 1. New Piping: One-piece, floor-plate type.

### **3.2 FIELD QUALITY CONTROL**

- A. Replace broken and damaged escutcheons and floor plates using new materials.

### **END OF SECTION 23 05 18**

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## **SECTION 23 05 19 - METERS AND GAGES FOR HVAC PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Liquid-in-glass thermometers.
  - 2. Thermowells.
  - 3. Dial-type pressure gages.
  - 4. Gage attachments.
  - 5. Test plugs.
  - 6. Test-plug kits.
  - 7. Sight flow indicators.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Product Certificates: For each type of meter and gage, from manufacturer.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

### **PART 2 - PRODUCTS**

#### **2.1 LIQUID-IN-GLASS THERMOMETERS**

- A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. Flo Fab Inc.
    - b. Miljoco Corporation.
    - c. Palmer Wahl Instrumentation Group.



- d. Tel-Tru Manufacturing Company.
  - e. Trerice, H. O. Co.
  - f. Weiss Instruments, Inc.
  - g. Winters Instruments - U.S.
2. Standard: ASME B40.200.
  3. Case: Brass; 9-inch (229-mm) nominal size unless otherwise indicated.
  4. Case Form: Adjustable angle unless otherwise indicated.
  5. Tube: Glass with magnifying lens and red organic liquid.
  6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F (deg C).
  7. Window: Glass.
  8. Stem: Brass and of length to suit installation.
    - a. Design for Air-Duct Installation: With ventilated shroud.
    - b. Design for Thermowell Installation: Bare stem.
  9. Connector: 1-1/4 inches (32 mm), with ASME B1.1 screw threads.
  10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

## 2.2 THERMOWELLS

### A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CUNI.
4. Material for Use with Steel Piping: CRES.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch (13, 19, and 25 mm), with ASME B1.1 screw threads.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

### B. Heat-Transfer Medium: Mixture of graphite and glycerin.

## 2.3 PRESSURE GAGES

### A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - a. AMETEK, Inc.; U.S. Gauge.
  - b. Ashcroft Inc.
  - c. Ernst Flow Industries.
  - d. Flo Fab Inc.
  - e. Marsh Bellofram.
  - f. Miljoco Corporation.
  - g. Noshok.
  - h. Palmer Wahl Instrumentation Group.

- i. REOTEMP Instrument Corporation.
  - j. Tel-Tru Manufacturing Company.
  - k. Trerice, H. O. Co.
  - l. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  - m. Weiss Instruments, Inc.
  - n. WIKA Instrument Corporation - USA.
  - o. Winters Instruments - U.S.
2. Standard: ASME B40.100.
  3. Case: Liquid-filled Sealed Solid-front, pressure relief type(s); cast aluminum or drawn steel; 4-1/2-inch (114-mm) nominal diameter.
  4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
  5. Pressure Connection: Brass, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
  6. Movement: Mechanical, with link to pressure element and connection to pointer.
  7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi (kPa).
  8. Pointer: Dark-colored metal.
  9. Window: Glass.
  10. Ring: Brass.
  11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

## 2.4 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of brass pipe with NPS 1/4 (DN 8) pipe threads.
- C. Valves: Brass ball, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads.

## 2.5 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  1. Flow Design, Inc.
  2. Miljoco Corporation.
  3. National Meter, Inc.
  4. Peterson Equipment Co., Inc.
  5. Sisco Manufacturing Company, Inc.
  6. Trerice, H. O. Co.
  7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  8. Weiss Instruments, Inc.
- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 (DN 8), ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
- F. Core Inserts: Chlorosulfonated polyethylene and EPDM synthetic self-sealing rubber.

## 2.6 TEST-PLUG KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
1. Flow Design, Inc.
  2. Miljoco Corporation.
  3. National Meter, Inc.
  4. Peterson Equipment Co., Inc.
  5. Sisco Manufacturing Company, Inc.
  6. Trerice, H. O. Co.
  7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
  8. Weiss Instruments, Inc.
- B. Furnish two test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F (minus 4 to plus 52 deg C).
- D. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F (minus 18 to plus 104 deg C).
- E. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).
- F. Carrying Case: Metal or plastic, with formed instrument padding.

## 2.7 SIGHT FLOW INDICATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
1. Archon Industries, Inc.
  2. Dwyer Instruments, Inc.
  3. Emerson Process Management; Brooks Instrument.
  4. Ernst Co., John C., Inc.
  5. Ernst Flow Industries.
  6. KOBOLD Instruments, Inc. - USA; KOBOLD Messring GmbH.
  7. OPW Engineered Systems; a Dover company.
  8. Penberthy; A Brand of Tyco Valves & Controls - Prophetstown.
- B. Description: Piping inline-installation device for visual verification of flow.
- C. Construction: Bronze or stainless-steel body, with sight glass and ball, flapper, or paddle wheel indicator, and threaded or flanged ends.
- D. Minimum Pressure Rating: 150 psig (1034 kPa).
- E. Minimum Temperature Rating: 200 deg F (93 deg C).
- F. End Connections for NPS 2 (DN 50) and Smaller: Threaded.
- G. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install thermowells with socket extending a minimum of 2 inches (51 mm) into fluid and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.
- G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- H. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- I. Install remote-mounted pressure gages on panel.
- J. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- K. Install valve and syphon fitting in piping for each pressure gage for steam.
- L. Install test plugs in piping tees.
- M. Install flow indicators in piping systems in accessible positions for easy viewing.
- N. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- O. Install flowmeter elements in accessible positions in piping systems.
- P. Install wafer-orifice flowmeter elements between pipe flanges.
- Q. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
- R. Install permanent indicators on walls or brackets in accessible and readable positions.
- S. Install connection fittings in accessible locations for attachment to portable indicators.
- T. Mount thermal-energy meters on wall if accessible; if not, provide brackets to support meters.
- U. Install thermometers in the following locations:
  - 1. Inlet and outlet of each hydronic zone.
  - 2. Inlet and outlet of each hydronic coil in air-handling units.
  - 3. Two inlets and two outlets of each hydronic heat exchanger.
  - 4. Other locations as shown on drawings.

- V. Install pressure gages in the following locations:
1. Inlet and Discharge of each pressure-reducing valve.
  2. Suction and discharge of each pump.
  3. Inlet and outlet of each hydronic coil in air handling units.
  4. Two inlets and two outlets of each hydronic heat exchanger.
  5. Other locations as shown on drawings.

### **3.2 CONNECTIONS**

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Connect thermal-energy meter transmitters to meters.

### **3.3 ADJUSTING**

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

### **3.4 THERMOMETER SCHEDULE**

- A. Thermometers shall be the following:
  1. Industrial-style, liquid-in-glass type.
  2. Test plug with self-sealing rubber inserts.
- B. Thermometer stems shall be of length to match thermowell insertion length.

### **3.5 THERMOMETER SCALE-RANGE SCHEDULE**

- A. Scale Range for Chilled-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).
- B. Scale Range for Heating, Hot-Water Piping: 30 to 250 deg F (0 to 150 deg C).
- C. Scale Range for Steam and Steam-Condensate Piping: 0 to 250 deg F (0 to 150 deg C).
- D. Scale Range for Air Ducts: 0 to 100 deg F (Minus 20 to plus 50 deg C).

### **3.6 PRESSURE-GAGE SCHEDULE**

- A. Pressure gages shall be the following:
  1. Liquid-filled Sealed Solid-front, pressure-relief, direct-mounted, metal case.
  2. Test plug with EPDM self-sealing rubber inserts.

### **3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE**

- A. Scale Range for Chilled-Water Piping: 0 to 100 psi (0 to 687.5 kPa).
- B. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi (0 to 687.5 kPa).
- C. Scale Range for Low Pressure Steam Piping: (-) 1- to 40 psi; show vacuum.

**END OF SECTION 23 05 19**

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## **SECTION 23 05 23 - GENERAL-DUTY VALVES FOR HVAC PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Bronze ball valves.
  - 2. Iron, general service butterfly valves.
  - 3. Carbon Steel High-performance butterfly valves.
  - 4. Bronze silent check valves.
  - 5. Iron globe silent check valves.
  - 6. Bronze swing-check valves.
  - 7. Iron swing-check valves.
  - 8. Bronze gate valves.
  - 9. Iron gate valves.
  - 10. Bronze globe valves.
  - 11. Iron globe valves.
  - 12. Eccentric plug valves.
  - 13. Strainers.
  - 14. Vacuum Breakers.
  - 15. Chainwheels.

#### **1.3 DEFINITIONS**

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.
- H. PTFE: Polytetrafluoroethylene
- I. TFE: Tetrafluoroethylene

## 1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated.

## 1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
  - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  - 2. ASME B31.1 for power piping valves.
  - 3. ASME B31.9 for building services piping valves.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads, flange faces, grooves, and weld ends.
  - 3. Set angle, gate, and globe valves closed to prevent rattling.
  - 4. Set ball and plug valves open to minimize exposure of functional surfaces.
  - 5. Set butterfly valves closed or slightly open.
  - 6. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

## PART 2 - PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to HVAC valve tables in Part 3 below for applications of valves. Valves of similar type shall be by single manufacturer.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures. Valves shall have name of manufacturer and guaranteed working pressure cast or stamped on bodies. Gaskets and packings shall not contain asbestos.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valve Actuator Types:
  - 1. Gear Actuator: For quarter-turn valves NPS 8 DN 200 and larger.
  - 2. Handwheel: For valves other than quarter-turn types.
  - 3. Handlever: For quarter-turn valves NPS 6 DN 150 and smaller except plug valves.
  - 4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
  - 5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.



- E. Valves in Insulated Piping: With 2-inch 50-mm stem extensions and the following features:
  - 1. Gate Valves: With rising stem.
  - 2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
  - 3. Butterfly Valves: With extended neck.
- F. Valve-End Connections:
  - 1. Flanged: With flanges according to ASME B16.1 for iron valves.
  - 2. Solder Joint: With sockets according to ASME B16.18.
  - 3. Threaded: With threads according to ASME B1.20.1.
- G. Valve Bypass and Drain Connections: MSS SP-45.

## 2.2 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. Cannon
    - b. Conbraco Industries, Inc.; Apollo Valves.
    - c. Crane Co.; Crane Valve Group; Crane Valves.
    - d. Grinnell
    - e. Hammond Valve.
    - f. Kitz
    - g. Milwaukee Valve Company.
    - h. NIBCO INC.
    - i. Rockwell
    - j. Stockham
    - k. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Description:
    - a. Standard: MSS SP-110.
    - b. Stem: Stainless steel.
    - c. Ball: Stainless steel, vented.
    - d. Refer to schedules in Part 3 for specific application requirements.
- B. Three-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. Cannon
    - b. Conbraco Industries, Inc.; Apollo Valves.
    - c. Grinnell
    - d. Hammond Valve.
    - e. Milwaukee Valve Company.
    - f. NIBCO INC.
    - g. Rockwell
    - h. Stockham
  - 2. Description:
    - a. Standard: MSS SP-110.
    - b. Stem: Stainless steel.
    - c. Ball: Stainless steel, vented.
    - d. Refer to schedules in Part 3 for specific application requirements.

## **2.3 CARBON STEEL HIGH-PERFORMANCE BUTTERFLY VALVES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
1. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.
  2. Bray Controls; a division of Bray International.
  3. DeZurik Water Controls.
  4. Flowseal
  5. Keystone
  6. Posi-Seal
- B. Description:
1. Standard: MSS SP-68
  2. Stem: Stainless steel; offset from seat plane.
  3. Disc: 316 stainless steel.
  4. Service: Bidirectional.
  5. Refer to schedules in Part 3 for specific application requirements.

## **2.4 BRONZE SILENT CHECK VALVES (PUMP DISCHARGE)**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
1. Crane Co.; Crane Valve Group; Crane Valves.
  2. Crane Co.; Crane Valve Group; Jenkins Valves.
  3. Crane Co.; Crane Valve Group; Stockham Division.
  4. Milwaukee Valve Company.
  5. Mueller Steam Specialty; a division of SPX Corporation.
- B. Description:
1. Standard: MSS SP-80, Type 1.
  2. Disc: BUNA/TFE.
  3. Refer to schedules in Part 3 for specific application requirements.

## **2.5 IRON, GLOBE SILENT CHECK VALVES (Pump discharge)**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
1. Crane Co.; Crane Valve Group; Crane Valves.
  2. Crane Co.; Crane Valve Group; Jenkins Valves.
  3. Crane Co.; Crane Valve Group; Stockham Division.
  4. Milwaukee Valve Company.
  5. Mueller Steam Specialty; a division of SPX Corporation.
- B. Description:
1. Standard: MSS SP-125.
  2. Disc: Bronze.
  3. Refer to schedules in Part 3 for specific application requirements.

## **2.6 BRONZE SWING CHECK VALVES**

- A. Bronze Swing Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.

- c. Crane Co.; Crane Valve Group; Stockham Division.
  - d. Hammond Valve.
  - e. Kitz Corporation.
  - f. Milwaukee Valve Company.
  - g. NIBCO INC.
  - h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
- a. Standard: MSS SP-80, Type 4.
  - b. Body Design: Horizontal flow.
  - c. Disc: PTFE unless indicated otherwise in table.
  - d. Refer to schedules in Part 3 for specific application requirements.

**B. Bronze Swing Check Valves with Bronze Disc:**

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Jenkins Valves.
  - c. Crane Co.; Crane Valve Group; Stockham Division.
  - d. Kitz Corporation.
  - e. Milwaukee Valve Company.
  - f. NIBCO INC.
- 2. Description:
  - a. Standard: MSS SP-80, Type 3.
  - b. Body Design: Horizontal flow.
  - c. Refer to schedules in Part 3 for specific application requirements.

**2.7 IRON SWING CHECK VALVES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
- 1. Crane Co.; Crane Valve Group; Crane Valves.
  - 2. Crane Co.; Crane Valve Group; Jenkins Valves.
  - 3. Crane Co.; Crane Valve Group; Stockham Division.
  - 4. Hammond Valve.
  - 5. Kitz Corporation (Class 125).
  - 6. Legend Valve (Class 125).
  - 7. Milwaukee Valve Company.
  - 8. NIBCO INC.
  - 9. Powell Valves (Class 125).
- B. Description:
- 1. Standard: MSS SP-71, Type I.
  - 2. Body Design: Clear or full waterway.
  - 3. Gasket: Asbestos free.
  - 4. Refer to schedules in Part 3 for specific application requirements.

**2.8 BRONZE GATE VALVES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
- 1. Crane Co.; Crane Valve Group; Crane Valves.
  - 2. Crane Co.; Crane Valve Group; Jenkins Valves.
  - 3. Crane Co.; Crane Valve Group; Stockham Division.
  - 4. Hammond Valve.
  - 5. Milwaukee Valve Company.
  - 6. NIBCO INC.

- B. Description:
1. Standard: MSS SP-80, Type 2.
  2. Packing: Asbestos free.
  3. Handwheel: Malleable iron or bronze.
  4. Refer to schedules in Part 3 for specific application requirements.

## 2.9 IRON GATE VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
1. Crane Co.; Crane Valve Group; Crane Valves.
  2. Crane Co.; Crane Valve Group; Jenkins Valves (Class 125).
  3. Crane Co.; Crane Valve Group; Stockham Division.
  4. Hammond Valve.
  5. Milwaukee Valve Company.
  6. NIBCO INC.
- B. Description:
1. Standard: MSS SP-70, Type I.
  2. Disc: Solid wedge.
  3. Packing and Gasket: Asbestos free.
  4. Refer to schedules in Part 3 for specific application requirements.

## 2.10 BRONZE GLOBE VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
1. Crane Co.; Crane Valve Group; Crane Valves.
  2. Crane Co.; Crane Valve Group; Stockham Division (Class 125).
  3. Grinnell
  4. Hammond Valve.
  5. Milwaukee Valve Company.
  6. NIBCO INC.
  7. Walworth
- B. Description:
1. Standard: MSS SP-80, Type 1 (Class 125).
  2. Standard: MSS SP-80, Type 2 (Class 150)
  3. Packing: Asbestos free.
  4. Handwheel: Malleable iron or bronze.
  5. Refer to schedules in Part 3 for specific application requirements.

## 2.11 IRON GLOBE VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
1. Crane Co.; Crane Valve Group; Crane Valves.
  2. Crane Co.; Crane Valve Group; Jenkins Valves.
  3. Crane Co.; Crane Valve Group; Stockham Division.
  4. Grinnell
  5. Hammond Valve.
  6. Milwaukee Valve Company.
  7. NIBCO INC. (Class 125)
  8. Walworth

- B. Description:
1. Standard: MSS SP-85, Type I
  2. Packing and Gasket: Asbestos free.
  3. Refer to schedules in Part 3 for specific application requirements.

## 2.12 ECCENTRIC PLUG VALVES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
1. DeZurik Water Controls.
  2. Mueller
  3. Rockwell
  4. Stockham
  5. Walworth
- B. Description:
1. Standard: MSS SP-108.
  2. Bearings: Oil-impregnated bronze or stainless steel.
  3. Stem-Seal Packing: Asbestos free.
  4. Plug, Resilient-Seating Material: Suitable for potable-water service unless otherwise indicated.
  5. Refer to schedules in Part 3 for specific application requirements.

## 2.13 STRAINERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
1. Sarco
  2. Mueller
  3. Watts
  4. Armstrong
- B. Description:
1. For water service, strainers shall be full size of entering pipe size and have a maximum clean pressure drop of one psi.
  2. For steam and steam condensate strainers shall be full size of entering pipe size and have a maximum clean pressure drop of 1/4 psi.
  3. Pump start up strainer screens shall be used for cleaning and removed afterwards.
  4. Provide blow-off valve on each strainer.
    - a. Provide bronze strainers with end cap with threaded connection for blow off valve.
    - b. Provide iron valves with bolted cover with threaded connection for blow off valve.
  5. For clean steam and clean steam condensate, provide stainless steel.
  6. Refer to schedules in Part 3 for specific application requirements.

## 2.14 VACUUM BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
1. Stockham
  2. Milwaukee
  3. Watts
- B. Description:
1. Vacuum breaker shall be installed in the horizontal position, flow arrow pointed towards the coil and of same size as connected pipe.

2. Mount vacuum breaker above connected pipe and enter pipe tee via 90 degree ell-drop after vacuum breaker. Inlet to vacuum breaker shall be piped so that it does not allow discharge from a faulty vacuum breaker to spray on someone or electrical or wet-sensitive equipment. Piping shall turn towards pieces of equipment served.
3. Refer to schedules in Part 3 for specific application requirements.

## **2.15 CHAINWHEELS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  1. Babbitt Steam Specialty Co.
  2. Roto Hammer Industries.
  3. Trumbull Industries.
- B. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
  1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
  2. Attachment: For connection to ball, butterfly, gate and globe valve stems.
  3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. Provide zinc coating.
  4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

### **3.2 VALVE INSTALLATION**

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.

- E. Install chainwheels on operators for ball, butterfly, gate and globe valves NPS 3 DN 75 and larger and more than 84 inches 2100 mm above floor. Extend chains to 60 inches 1520 mm above finished floor.
- F. Install check valves for proper direction of flow and as follows:
  - 1. Swing Check Valves: In horizontal position with hinge pin level.
  - 2. Silent Check Valves: In horizontal or vertical position, between flanges.

### **3.3 ADJUSTING**

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

### **3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS**

- A. Valves on steam, steam condensate, condenser water, chilled water, hot water and glycol services shall be as shown in the following tables. If valve applications are not indicated, use the following:
  - 1. Shutoff Service: Ball, butterfly, or gate valves.
  - 2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
  - 3. Throttling Service except Steam: Globe, ball, or butterfly valves.
  - 4. Throttling Service, Steam: Globe valves.
  - 5. Pump-Discharge Check Valves:
    - a. NPS 2 DN 50 and Smaller: Spring wafer check valve with bronze disc. .
    - b. NPS 2-1/2 DN 65 and Larger: Iron, center-guided, metal -seat check valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves with end connections as indicated in the tables. For applications not listed in the tables select valves, except wafer types, with the following end connections:
  - 1. For Copper Tubing, NPS 2 DN 50 and Smaller: Threaded ends.
  - 2. For Steel Piping, NPS 2 DN 50 and Smaller: Threaded ends.
  - 3. For Steel Piping, NPS 2-1/2 to NPS 4 DN 65 to DN 100: Flanged ends.
  - 4. For Steel Piping, NPS 5 DN 125 and Larger: Flanged ends.

STEAM AND CONDENSATE SERVICE Maximum 90 psig Saturated Steam						
Specialty	Application	Type	Size (inches)	Body/Seat Body/Trim	Connection	Minimum Rating, <sup>1, 2</sup>
Ball Valve	Not used					
Ball Valve	Clean Steam and Clean Condensate	One Piece	1/2 - 2	316 Stainless Steel	Threaded	150 psig
Gate Valve	Isolation	Union Bonnet	1/2 - 2	Bronze/Bronze Bronze/Bronze	Threaded	Class 125
		OS&Y	2-1/2 - 36	Iron/Bronze Iron/Iron	Flanged	Class 125
Globe Valve	Manual Steam Modulation Only and Automatic Control	Union Bonnet	1/2 - 2	Bronze/Stainless Bronze/Bronze	Threaded	125 psig SWP
		OS&Y	2-1/2 - 10	Iron/Bronze	Flanged	Class 125
Butterfly Valve	Not Used					
Plug Valve	Not Used					
Check Valve	Steam and Condensate Horizontal Flow	Non-Y-Type Swing Check Valve	1/2 - 2	Bronze/Teflon	Threaded (Use Dielectrics for Condensate)	125 psig SWP
			2-1/2 - 30	Iron/Iron	Flanged	125 SWP
Strainer	Control Valves and Flow Meters and Steam Traps	Y-Type	1/2 - 2	Bronze/Stainless (1/16 inch dia.)	Threaded	Class 125
			2-1/2 - 10	Iron/Stainless (3/64 inch dia.)	Flanged	Class 125
			12 - 24	Iron/Stainless (1/16 inch dia.)	Flanged	Class 125
Vacuum Breaker	Steam Coils and HX and Condensate Trap Legs	Non-Y-Type Swing Check Valve	1/2 - 2	Bronze/Teflon	Threaded (Use Dielectrics for Condensate)	Class 125

1. These are minimum ratings. For actual maximum allowable valve and strainer ratings, refer to "Pressure Temperature Ratings-Non Shock" tables.

2. SWP = Steam Working Pressure    WOG = Water, Oil or Gas  
WSP = Working Steam Pressure    Class = ANSI Standard



GLYCOL, CHILLED AND CONDENSER WATER SERVICE Maximum 150°F and 150 psig (1/2 inch - 12 inches), 125 psig (14 inches - 24 inches)						
Specialty	Application	Type	Size (inches)	Body/Seat Body/Trim	Connection	Minimum Rating <sup>1,2</sup>
Ball Valve	Isolation (with locking handle) and Modulation	Full Port 3-pc.	1/2 - 2	Bronze/Teflon	Sweat <sup>1</sup>	400 psig WOG
		Full Port 2 pc.	1/2 - 2	Bronze/Teflon	Threaded	400 psig WOG
Gate Valve	Not Used					
Globe Valve	ATC Modulation	Control Valve	1/2 - 2	Bronze/Metal	Threaded	400 psig WOG
			2-1/2 - 6	Bronze/Metal	Flanged	400 psig WOG
Butterfly Valve	Isolation and Modulation	High Performance	2-1/2 - 12	Stainless Steel/Stainless Steel	Threaded Lug	285 psig CWP 150 psig bi-directional shutoff 150 psig dead end service, blowout-proof stem
		High Performance	14 - 24	Stainless Steel/Stainless Steel	Threaded Lug	285 psig CWP 150 psig bi-directional shutoff 150 psig dead end service, blowout-proof stem
Plug Valve	Manual Balancing	Non-lubricated	3 - 12	Steel/Iron	Flanged	Class 125
Check Valve	Pumps	Silent	1/2 - 2	Bronze/Bronze	Threaded	200 psig WOG
		Silent Globe	2-1/2 - 24	Iron/Bronze	Flanged	Class 125
	Piping	Y-Pattern Swing	1/2 - 2	Bronze/Bronze	Threaded	200 psig WOG
			2-1/2 - 24	Iron/Bronze	Flanged	Class 125
Strainer	Control Valves and Flow Meters	Y-Type	1/2 - 2	Bronze/Stainless (1/16 inch dia.)	Threaded	200 psig WOG
			2-1/2 - 4	Iron/Stainless (1/16 inch dia.)	Flanged	Class 125
			5 - 24	Iron/Stainless (1/8 inch dia.)	Flanged	Class 125
	Pump Suction	In-Line Y-Type	1/2 - 2	Bronze/Stainless (1/16 inch dia.)	Threaded	200 psig WOG
			2-1/2 - 4	Iron/Stainless (3/16 inch dia.) <sup>3</sup>	Flanged	Class 125
			5 - 24	Iron/Stainless (1/4 inch dia.) <sup>3</sup>	Flanged	Class 125
		Angle Suction Diffuser End Suction Pumps	2 - 12	Iron/Stainless (3/16 inch dia.) <sup>3</sup> Start Up Strainer = 16 Mesh Bronze	Flanged	Class 125

1. These are minimum ratings for ASTM A126, Class B and ASTM B-61 and 62. For higher pressures and temperatures, adjust these values to include static head plus 1.1 times pressure relief valve setting plus pump shutoff head pressure. For actual maximum allowable valve and strainer ratings, refer to "Pressure-Temperature Ratings - Non Shock" tables and "Adjusted Pressure Ratings" for copper tube, soldered end valves [and strainers].

2. SWP=Steam Working Pressure CWP=Cold Water Working Pressure  
WSP=Working Steam Pressure WOG=Water, Oil or Gas  
Class=ANSI Standard

3. Use 1/8 inch dia. for plate heat exchanger application.

GLYCOL AND HOT WATER SERVICE Maximum 250°F and 175 psig (½"-12")/125 psig (14"-24")						
Specialty	Application	Type	Size (inches)	Body/Seat, Body/Trim	Connection	Minimum Rating <sup>1,2</sup>
Ball Valve	Isolation (with locking handle) and Modulation	Full Port 3-pc.	1/2 - 2	Bronze/Teflon	Sweat <sup>1</sup>	400 psig WOG
		Full Port 2 pc.	1/2 - 2	Bronze/Teflon	Threaded	400 psig WOG
Gate Valve	Not Used					
Globe Valve	ATC Modulation	Control Valve	1/2 - 2	Bronze/Metal	Threaded	400 psig WOG
			2-1/2 - 6	Bronze/Metal	Flanged	400 psig WOG
Butterfly Valve	Isolation and Modulation	High Performance	2-1/2 - 12	Stainless Steel/Stainless Steel	Threaded Lug	285 psig CWP 150 psig bi-directional shutoff 150 psig dead end service, blowout-proof stem
			14 - 24	Stainless Steel/Stainless Steel	Threaded Lug	285 psig CWP 150 psig bi-directional shutoff 150 psig dead end service, blowout-proof stem
Plug Valve	Manual Balancing	Non-lubricated	3 -12	Steel/Iron	Flanged	Class 125
Check Valve	Pumps	Silent	1/2 - 2	Bronze/Bronze	Threaded	200 psig WOG
		Silent Globe	2-1/2 - 24	Iron/Bronze	Flanged	Class 125
	Piping	Y-Pattern Swing	1/2 - 2	Bronze/Bronze	Threaded	200 psig WOG
			2-1/2 - 24	Iron/Bronze	Flanged	Class 125
Strainer	Control Valves and Flow Meters	Y-Type	1/2 - 2	Bronze/Stainless (1/16" dia.)	Threaded	200 psig WOG
			2-1/2 - 4	Iron/Stainless (1/16" dia.)	Flanged	Class 125
			5 - 24	Iron/Stainless (1/8" dia.)	Flanged	Class 125
	Pump Suction	In-Line Y-Type	1/2 - 2	Bronze/Stainless (1/16" dia.)	Threaded	200 psig WOG
			2-1/2 - 4	Iron/Stainless (3/16" dia.) <sup>3</sup>	Flanged	Class 125
			5 -24	Iron/Stainless (¼" dia.) <sup>3</sup>	Flanged	Class 125
			Angle Suction Diffuser End Suction Pumps	2 - 12	Iron/Stainless (3/16" dia.) <sup>3</sup> Start Up Strainer = 16 Mesh Bronze	Flanged

1. These are minimum ratings for ASTM A126, Class B and ASTM B-61 and 62. For higher pressures and temperatures, adjust these values to include static head plus 1.1 times pressure relief valve setting plus pump shutoff head pressure. For actual maximum allowable valve and strainer ratings, refer to "Pressure-Temperature Ratings - Non Shock" tables and "Adjusted Pressure Ratings" for copper tube, soldered end valves [and strainers].

2. SWP=Steam Working Pressure CWP=Cold Water Working Pressure  
WSP=Working Steam Pressure WOG=Water, Oil or Gas  
Class=ANSI Standard

3. Use 1/8 inch dia. for plate heat exchanger application.

**END OF SECTION**



## **SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

### **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 hangers and supports for HVAC system piping and equipment:
  - 1. Steel pipe hangers and supports.
  - 2. Trapeze pipe hangers.
  - 3. Metal framing systems.
  - 4. Thermal-hanger shield inserts.
  - 5. Fastener systems.
  - 6. Pipe stands.
  - 7. Equipment supports.
- B. Related Sections include the following:
  - 1. Division 05 for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

#### **1.3 DEFINITIONS**

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

#### **1.5 SUBMITTALS**

- A. Product Data: For the following:
  - 1. Steel pipe hangers and supports.
  - 2. Thermal-hanger shield inserts.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Pipe stands. Include Product Data for components.
4. Equipment supports.

C. Welding certificates.

## **1.6 QUALITY ASSURANCE**

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel." and AWS D1.3, "Structural Welding Code--Sheet Steel."

B. Welding: Qualify procedures and personnel according to the following:

1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.2, "Structural Welding Code--Aluminum."
3. AWS D1.3, "Structural Welding Code--Sheet Steel."

## **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 manufacturers specified or approved equivalent.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### **2.2 STEEL PIPE HANGERS AND SUPPORTS**

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:

1. B-Line Systems, Inc.; a division of Cooper Industries.
2. Carpenter & Paterson, Inc.
3. Empire Industries, Inc.
4. ERICO/Michigan Hanger Co.
5. Globe Pipe Hanger Products, Inc.
6. Grinnell Corp.
7. National Pipe Hanger Corporation.
8. PHD Manufacturing, Inc.
9. PHS Industries, Inc.
10. Piping Technology & Products, Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

### **2.3 TRAPEZE PIPE HANGERS**

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

### **2.4 METAL FRAMING SYSTEMS**

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - 1. B-Line Systems, Inc.; a division of Cooper Industries.
  - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
  - 3. GS Metals Corp.
  - 4. Power-Strut Div.; Tyco International, Ltd.
  - 5. Thomas & Betts Corporation.
  - 6. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

### **2.5 THERMAL-HANGER SHIELD INSERTS**

- A. Description: 100-psig- (690-kPa-) minimum, compressive-strength insulation insert encased in sheet metal shield. Insert shall be capable of supporting weight of pipe, insulations and fluid without crushing.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - 1. Carpenter & Paterson, Inc.
  - 2. ERICO/Michigan Hanger Co.
  - 3. PHS Industries, Inc.
  - 4. Pipe Shields, Inc.
  - 5. Rilco Manufacturing Company, Inc.
  - 6. Value Engineered Products, Inc.
- C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.
- D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

- G. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

## 2.6 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated or stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. B-Line Systems, Inc.; a division of Cooper Industries.
    - b. Empire Industries, Inc.
    - c. Hilti, Inc.
    - d. ITW Ramset/Red Head.
    - e. MKT Fastening, LLC.
    - f. Powers Fasteners.

## 2.7 PIPE STAND FABRICATION

- A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. ERICO/Michigan Hanger Co.
    - b. MIRO Industries.
- C. Low-Type, Single-Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. MIRO Industries.
- D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. ERICO/Michigan Hanger Co.
    - b. MIRO Industries.
    - c. Portable Pipe Hangers.
  - 2. Base: Stainless steel.
  - 3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
  - 4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

- E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. Portable Pipe Hangers.
  - 2. Bases: One or more plastic.
  - 3. Vertical Members: Two or more protective-coated-steel channels.
  - 4. Horizontal Member: Protective-coated-steel channel.
  - 5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.
- F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

## **2.8 EQUIPMENT SUPPORTS**

- A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

## **2.9 MISCELLANEOUS MATERIALS**

- A. Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and non-metallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

## **PART 3 - EXECUTION**

### **3.1 HANGER AND SUPPORT APPLICATIONS**

- A. Specific hanger and support requirements are specified in other Division 23 Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that shall not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:



1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
  2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F (49 to 232 deg C) pipes, NPS 4 to NPS 16 (DN 100 to DN 400), requiring up to 4 inches (100 mm) of insulation.
  3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24 (DN 20 to DN 600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
  4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24 (DN 15 to DN 600), if little or no insulation is required.
  5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
  6. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3 (DN 10 to DN 80).
  7. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
  8. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  9. Pipe Saddle Supports (MSS Type 36): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange.
  10. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange and with U-bolt to retain pipe.
  11. Adjustable, Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes, NPS 2-1/2 to NPS 36 (DN 65 to DN 900), if vertical adjustment is required, with steel pipe base stanchion support and cast-iron floor flange.
  12. Single Pipe Rolls (MSS Type 41): For suspension of pipes, NPS 1 to NPS 30 (DN 25 to DN 750), from 2 rods if longitudinal movement caused by expansion and contraction might occur.
  13. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes, NPS 2-1/2 to NPS 20 (DN 65 to DN 500), from single rod if horizontal movement caused by expansion and contraction might occur.
  14. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42 (DN 50 to DN 1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
  15. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24 (DN 50 to DN 600), if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
  16. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN 50 to DN 750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500).
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500), if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
  3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
  4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below, or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb (340 kg).
    - b. Medium (MSS Type 32): 1500 lb (680 kg).
    - c. Heavy (MSS Type 33): 3000 lb (1360 kg).
  13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
  2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches (32 mm).
  3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41 roll hanger with springs.
  4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
  5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from hanger.
  6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from base support.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to absorb expansion and contraction of piping system from trapeze support.
  8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
    - a. Horizontal (MSS Type 54): Mounted horizontally.
    - b. Vertical (MSS Type 55): Mounted vertically.
    - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.
- L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.
  - M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
  - N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

### **3.2 HANGER AND SUPPORT INSTALLATION**

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89, or standards in Tables 1 and 2, whichever is stricter. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
  1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
  2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
  1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Pipe Stand Installation:
  1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
  2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.
- G. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

- H. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- J. Install lateral bracing with pipe hangers and supports to prevent swaying.
- K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- L. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement shall not be transmitted to connected equipment.
- M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- N. Insulated Piping: Comply with the following:
  - 1. Attach clamps and spacers to piping.
    - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    - c. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
  - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
  - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
  - 4. Shield Dimensions for Pipe: Not less than the following:
    - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
    - b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
    - c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
    - d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
    - e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
  - 5. Pipes NPS 8 (DN 200) and Larger: Include wood inserts.
  - 6. Insert Material: Length at least as long as protective shield.
  - 7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### **3.3 EQUIPMENT SUPPORTS**

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make smooth bearing surface.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### **3.4 METAL FABRICATIONS**

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

### **3.5 ADJUSTING**

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

### **3.6 PAINTING**

- A. Touch Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
- B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**END OF SECTION 23 05 29**

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## **SECTION 23 05 48 - VIBRATION CONTROLS FOR HVAC**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes
  - 1. Vibration Isolation Devices:
    - a. Elastomeric isolation pads.
    - b. Elastomeric isolation mounts.
    - c. Restrained elastomeric isolation mounts.
    - d. Open-spring isolators.
    - e. Restrained-spring isolators.
    - f. Pipe-riser resilient supports.
    - g. Resilient pipe guides.
    - h. Elastomeric hangers.
    - i. Spring hangers.
    - j. Vibration isolation equipment bases.
    - k. Restrained isolation roof-curb rails.
- B. Related Requirements:
  - 1. Division 21 for vibration isolation and seismic devices for fire-suppression equipment and systems.
  - 2. Division 22 for vibration isolation and seismic devices for plumbing equipment and

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
  - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.
- B. Shop Drawings:
  - 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal:
1. For each vibration isolation device.
    - a. Include design calculations and details for selecting vibration isolators and vibration isolation bases.
    - b. Design Calculations: Calculate static and dynamic loading due to equipment weight and required to select vibration isolators and for designing vibration isolation bases.
      - 1) Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
    - c. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure and spring deflection changes. Include certification that riser system was examined for excessive stress and that none exists.
  2. Wind-Restraint Details:
    - a. Design Analysis: To support selection and arrangement of wind restraints. Include calculations of combined tensile and shear loads.
    - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacing. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during design wind speed. Indicate association with vibration isolation devices.
    - c. Comply with requirements in other Sections for equipment mounted outdoors.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings:
1. Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For professional engineer and testing agency.
- C. Welding certificates.
- D. Field quality-control reports.

#### **1.5 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

#### A. Wind-Restraint Loading:

1. Basic Wind Speed: 100 MPH.
2. Building Classification Category: III.
3. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) multiplied by maximum area of HVAC component projected on vertical plane normal to wind direction, and 45 degrees either side of normal.

### **2.2 ELASTOMERIC ISOLATION PADS**

#### A. Elastomeric Isolation Pads:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - a. Ace Mountings Co., Inc.
  - b. California Dynamics Corporation.
  - c. Isolation Technology, Inc.
  - d. Kinetics Noise Control, Inc.
  - e. Mason Industries, Inc.
  - f. Vibration Eliminator Co., Inc.
  - g. Vibration Isolation.
  - h. Vibration Mountings & Controls, Inc.
2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Smooth, Ribbed or Waffle pattern.
6. Load-bearing metal plates adhered to pads.
7. Sandwich-Core Material: Resilient and elastomeric .
  - a. Surface Pattern: Smooth, Ribbed or Waffle pattern.

### **2.3 ELASTOMERIC ISOLATION MOUNTS**

#### A. Double-Deflection, Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - a. Ace Mountings Co., Inc.
  - b. California Dynamics Corporation.
  - c. Isolation Technology, Inc.
  - d. Kinetics Noise Control, Inc.
  - e. Mason Industries, Inc.
  - f. Vibration Eliminator Co., Inc.
  - g. Vibration Isolation.
  - h. Vibration Mountings & Controls, Inc.
2. Mounting Plates:



- a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
  - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.4 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

### A. Restrained Elastomeric Isolation Mounts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - a. Ace Mountings Co., Inc.
  - b. California Dynamics Corporation.
  - c. Isolation Technology, Inc.
  - d. Kinetics Noise Control, Inc.
  - e. Mason Industries, Inc.
  - f. Vibration Eliminator Co., Inc.
  - g. Vibration Isolation.
  - h. Vibration Mountings & Controls, Inc.
2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
  - a. Housing: Cast-ductile iron or welded steel.
  - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.5 OPEN-SPRING ISOLATORS

### A. Freestanding, Laterally Stable, Open-Spring Isolators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - a. Ace Mountings Co., Inc.
  - b. California Dynamics Corporation.
  - c. Isolation Technology, Inc.
  - d. Kinetics Noise Control, Inc.
  - e. Mason Industries, Inc.
  - f. Vibration Eliminator Co., Inc.
  - g. Vibration Isolation.
  - h. Vibration Mountings & Controls, Inc.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the 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.
6. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig (3447 kPa).

7. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

## **2.6 RESTRAINED-SPRING ISOLATORS**

- A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. Ace Mountings Co., Inc.
    - b. California Dynamics Corporation.
    - c. Isolation Technology, Inc.
    - d. Kinetics Noise Control, Inc.
    - e. Mason Industries, Inc.
    - f. Vibration Eliminator Co., Inc.
    - g. Vibration Isolation.
    - h. Vibration Mountings & Controls, Inc.
  2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
    - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig (3447 kPa).
    - b. Top plate with threaded mounting holes and elastomeric pad.
    - c. Internal leveling bolt that acts as blocking during installation.
  3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
  4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## **2.7 PIPE-RISER RESILIENT SUPPORT**

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2 inch- (13-mm-) thick neoprene.
  1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
  2. Maximum Load Per Support: 500 psig (3.45 MPa) on isolation material providing equal isolation in all directions.

## **2.8 RESILIENT PIPE GUIDES**

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2 inch- (13-mm-) thick neoprene.
  1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

## 2.9 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. Ace Mountings Co., Inc.
    - b. California Dynamics Corporation.
    - c. Isolation Technology, Inc.
    - d. Kinetics Noise Control, Inc.
    - e. Mason Industries, Inc.
    - f. Vibration Eliminator Co., Inc.
    - g. Vibration Mountings & Controls, Inc.
  2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
  3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

## 2.10 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. Ace Mountings Co., Inc.
    - b. California Dynamics Corporation.
    - c. Kinetics Noise Control, Inc.
    - d. Mason Industries, Inc.
    - e. Vibration Eliminator Co., Inc.
    - f. Vibration Isolation.
    - g. Vibration Mountings & Controls, Inc.
  2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
  3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
  8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
  9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

## 2.11 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:

1. California Dynamics Corporation.
2. Kinetics Noise Control.
3. Mason Industries, Inc.
4. Vibration Eliminator Co., Inc.
5. Vibration Isolation.
6. Vibration Mountings & Controls, Inc.

B. Steel Rails: Factory-fabricated, welded, structural-steel rails.

1. Design Requirements: Lowest possible mounting height with not less than 1 inch (25-mm) clearance above the floor or structural support. Include equipment anchor bolts and auxiliary motor slide rails.
  - a. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. For equipment mounted outdoor, structural steel rails and hardware shall be corrosion resistant hot dipped galvanized steel.

C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1 inch (25-mm) clearance above the floor or structural support. Include equipment anchor bolts and auxiliary motor slide bases or rails.
  - a. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. For equipment mounted outdoor, structural steel rails and hardware shall be corrosion resistant hot dipped galvanized steel.

D. Concrete Inertia Base: Factory-fabricated or field-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1 inch (25-mm) clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
  - a. Include supports for suction and discharge elbows for pumps.
2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

## 2.12 RESTRAINED ISOLATION ROOF-CURB RAILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - 1. Ace Mountings Co., Inc.
  - 2. California Dynamics Corporation.
  - 3. Kinetics Noise Control.
  - 4. Mason Industries, Inc.
  - 5. Thybar Corporation.
- B. Description: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic and wind forces.
- C. Upper Frame: The upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic and wind forces.
- D. Lower Support Assembly: The lower support assembly shall be formed sheet metal section containing adjustable and removable steel springs that support the upper frame. The lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches (50 mm) of rigid, glass-fiber insulation on inside of assembly. Adjustable, restrained-spring isolators shall be mounted on elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.
- E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch (6 mm) thick.
- F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counter-flashed over roof materials.

## 2.13 THRUST RESTRAINTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - 1. Ace Mountings Co., Inc.
  - 2. California Dynamics Corporation.
  - 3. Kinetics Noise Control.
  - 4. Mason Industries, Inc.
  - 5. Thybar Corporation.
- B. Description: Spring element combined with steel angles, backup plates, threaded rod, washers and nuts to produce a pair of devices capable of limiting movement of air handling equipment to 0.25 inch.
- C. Restraint shall be convertible in the field from compression type to tension type.
- D. Unit shall be pre-compressed.

## 2.14 MECHANICAL ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:

1. Cooper B-Line, Inc.
  2. Hilti, Inc.
  3. Kinetics Noise Control, Inc.
  4. Mason Industries, Inc.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

## **2.15 ADHESIVE ANCHOR BOLTS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
1. Hilti, Inc.
  2. Kinetics Noise Control, Inc.
  3. Mason Industries, Inc.
- B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas and equipment to receive vibration isolation- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 APPLICATIONS**

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

### **3.3 VIBRATION CONTROL DEVICE INSTALLATION**

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03.
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

- C. Comply with requirements in Division 07 for installation of roof curbs, equipment supports, and roof penetrations.
- D. Piping Restraints:
  - 1. Comply with requirements in MSS SP-127.
  - 2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
  - 3. Brace a change of direction longer than 12 feet (3.7 m).
- E. Install cables so they do not bend across edges of adjacent equipment or building structure.
- F. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- I. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- J. Drilled-in Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
  - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
  - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

### **3.4 ADJUSTING**

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

### 3.5 VIBRATION ISOLATION EQUIPMENT BASES INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Division 03.

### 3.6 VIBRATION ISOLATION SCHEDULES

- A. Provide vibration isolators and equipment bases for all rotating, piston driven or vibrating equipment in accordance with the following schedules. Selection of equipment isolators shall be based on approved equipment shop drawings.

B.

Base & Isolator Types															
Base Types			Isolator Types												
A	No base, isolators attached directly to equipment.		1 Elastomeric pad.												
B	Structural steel rails or base.		2 Elastomeric floor mount or hanger. Use restrained elastomeric mount where seismic restraint is required.												
C	Concrete inertia base.		3 Spring floor isolator or hanger.												
D	Curb-mounted base.		4 Restrained spring isolator.												
			5 Thrust restraint.												

Vibration Isolation - Refrigeration Machines and Chillers															
Compressor Type	Horsepower and Other	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
Water Cooled Reciprocating	All	All	A	2	0.25	A	4	0.75	A	4	1.5	A	4	2.5	1
Water Cooled Centrifugal, Scroll	All	All	A	1	0.25	A	4	0.75	A	4	1.5	A	4	1.5	1,2,3
Water Cooled Centrifugal, Screw	All	All	A	1	1.0	A	4	1.5	A	4	2.5	A	4	2.5	1,2
Absorption	All	All	A	4	0.25	A	4	0.75	A	4	1.5	A	4	1.5	
Air Cooled, Reciprocating, Scroll	All	All	A	1	0.25	A	4	1.5	A	4	1.5	A	4	2.5	1,2,4
Air Cooled, Reciprocating, Screw	All	All	A	4	1.0	A	4	1.5	B	4	2.5	B	4	2.5	1,2,3,4

Notes:

- Increase isolator deflection so isolator stiffness is less than one-tenth the stiffness of the supporting structure, as defined by the deflection due to load at the equipment support.
- Where equipment manufacturer indicates component cannot be installed directly on individual isolators (type A), provide equipment manufacturer recommended supplemental support (base type).
- Select isolator deflection so that resonance frequency is 40 percent or less of the lowest normal operating speed of equipment. Add a 1 in. thick pad (type 1) to the base plate of spring isolators (type 3).
- Provide restrained isolators, supplemental bracing and snubbers required to account for wind loading conditions.



Vibration Isolation - Pumps															
Pump Type	Horsepower and Other	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
Close Coupled	≤7.5	All	B	2	0.25	C	3	0.75	C	3	0.75	C	3	0.75	1
	≥10	All	C	3	0.75	C	3	0.75	C	3	1.5	C	3	1.5	1
Large Inline	5 to 25	All	A	3	0.75	A	3	1.5	A	3	1.5	A	2	1.5	
	≥30	All	A	3	1.5	A	3	1.5	A	3	1.5	A	3	2.5	
End suction and split case	≤40	All	C	3	0.75	C	3	0.75	C	3	1.5	C	3	1.5	1
	50 to 125	All	C	3	0.75	C	3	0.75	C	3	1.5	C	3	2.5	1
	≥150	All	C	3	0.75	C	3	0.75	C	3	2.5	C	3	3.5	1
Packaged Pump Systems	All	All	A	3	0.75	A	3	0.75	A	3	1.5	C	3	2.5	

Notes:

- Pumps: Type C bases strength and shape shall accommodate base elbow supports. Concrete bases (type C) shall be designed for a thickness of one-tenth the longest dimension with minimum thickness as follows: (1) for up to 30 hp, 6 in.; (2) for 40 to 75 hp, 8 in.; and (3) for 100 hp and up, 12 in. Pumps over 75 hp and multistage pumps shall be provided with supplemental restraining devices.

Vibration Isolation - Axial Fans, Fan Heads, Cabinet Fans, Fan Sections															
Fan Size	Fan Static Pressure	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
Up to 22 in. diameter	All	All	A	2	0.25	A	3	0.75	A	3	0.75	C	3	0.75	1,2,3
24 in. diameter & up	≤2 in. SP	Up to 300	B	3	2.5	C	3	3.5	C	3	3.5	C	3	3.5	2,3
		300 to 500	B	3	0.75	B	3	1.5	C	3	2.5	C	3	2.5	2,3
		501 and up	B	3	0.75	B	3	1.5	B	3	1.5	B	3	1.5	2,3
	≥2.1 in. SP	Up to 300	C	3	2.5	C	3	3.5	C	3	3.5	C	3	3.5	2,3
		300 to 500	C	3	1.5	C	3	1.5	C	3	2.5	C	3	2.5	2,3
		501 and up	C	3	0.75	C	3	1.5	C	3	1.5	C	3	2.5	2,3

Notes:

- Where equipment manufacturer indicates component cannot be installed directly on individual isolators (type A) provide equipment manufacturer recommended supplemental support (base type).
- Select isolator deflection so that resonance frequency is 40 percent or less of the lowest normal operating speed of equipment. Add a 1 in. thick pad (type 1) to the base plate of spring isolators (type 3).
- To limit undesirable movement, thrust restraints (type 5) are required for all ceiling-suspended and floor-mounted units operating at 2 in. of water or more total static pressure.

Vibration Isolation - Centrifugal Fans															
Fan Size	Fan Horsepower	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
Up to 22 in. diameter	All	All	B	2	0.25	B	3	0.75	B	3	0.75	B	3	1.5	3,4
24 in. diameter & up	≤40	Up to 300	B	3	2.5	B	3	3.5	B	3	3.5	B	3	3.5	2,4
		300 to 500	B	3	1.5	B	3	1.5	B	3	2.5	B	3	2.5	2,4
		501 and up	B	3	0.75	B	3	0.75	B	3	0.75	B	3	1.5	2,4
	≥50	Up to 300	C	3	2.5	C	3	3.5	C	3	3.5	C	3	3.5	1,2,3,4
		300 to 500	C	3	1.5	C	3	1.5	C	3	2.5	C	3	2.5	1,2,3,4
		501 and up	C	3	1.0	C	3	1.5	C	3	1.5	C	3	2.5	1,2,3,4,

Notes:

- Increase isolator deflection so isolator stiffness is less than one-tenth the stiffness of the supporting structure, as defined by the deflection due to load at the equipment support.
- Select isolator deflection so that resonance frequency is 40 percent or less of the lowest normal operating speed of equipment. Add a 1 in. thick pad (type 1) to the base plate of spring isolators (type 3).
- Provide thrust restraints (type 5) for all ceiling-suspended and floor-mounted units operating at 2 in. of water or more total static pressure.
- Fans and Air-Handling Equipment: For fans operating under 300 rpm, select isolator deflection so the isolator natural frequency is 40 percent or less than the fan speed. Flexible duct connectors shall be installed at the intake and discharge of all fans and air-handling equipment to reduce vibration transmission to air duct structures. Provide inertia bases (type C) for all class 2 and 3 fans and air handling equipment. Provide thrust restraints (type 5) with same deflection as isolators for all fans and all base-mounted and suspended air-handling equipment operating at 2 in. or more total static pressure. Adjust restraint movement under normal operational static pressures.

Vibration Isolation - Heat Pumps, Fan Coil Units and Computer Room Units															
Equipment Type	Horsepower and Other	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
Heat Pumps, Fan Coil Units and Computer Room Units	All	All	A	3	0.75	A	3	0.75	A	3	0.75	A/D	3	1.5	

Vibration Isolation - Condensing Units															
Equipment Type	Horsepower and Other	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
Condensing Units	All	All	A	1	0.25	A	4	0.75	A	4	1.5	A/D	4	1.5	

Vibration Isolation - Packaged Air Handling Unit, Air Conditioning Units, Heating & Ventilating Units															
Fan Size	Fan HP, Static Pressure	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
All	≤10	All	A	3	0.75	A	3	0.75	A	3	0.75	A	3	0.75	5,6
	≥15, ≤4 in. SP	Up to 300	A	3	0.75	A	3	3.5	A	3	3.5	C	3	3.5	1,3,4,5,6
		300 to 500	A	3	0.75	A	3	2.5	A	3	2.5	A	3	2.5	3,5,6
		501 and up	A	3	0.75	A	3	1.5	A	3	1.5	A	3	1.5	3,5,6
	≥15, ≥4 in. SP	Up to 300	B	3	0.75	C	3	3.5	C	3	3.5	C	3	3.5	1,2,3,4,5
		300 to 500	B	3	0.75	C	3	1.5	C	3	2.5	C	3	2.5	1,2,3,5
		501 and up	B	3	0.75	C	3	1.5	C	3	1.5	C	3	2.5	1,2,3,5

Notes:

- Where available, use of packaged equipment manufacturer internal isolators meeting the above requirements is acceptable. Coordinate with equipment manufacturer. Provide documentation in both equipment submittals and in submittals for this Section.
- Increase isolator deflection so isolator stiffness is less than one-tenth the stiffness of the supporting structure, as defined by the deflection due to load at the equipment support.
- Where equipment manufacturer indicates component cannot be installed directly on individual isolators (type A) provide equipment manufacturer recommended supplemental support (base type).
- Select isolator deflection so that resonance frequency is 40 percent or less of the lowest normal operating speed of equipment. Add a 1 in. thick pad (type 1) to the base plate of spring isolators (type 3).
- Provide thrust restraints (type 5) for all ceiling-suspended and floor-mounted units operating at 2 in. of water or more total static pressure.
- Fans and Air-Handling Equipment: For fans operating under 300 rpm, select isolator deflection so the isolator natural frequency is 40 percent or less than the fan speed. Flexible duct connectors shall be installed at the intake and discharge of all fans and air-handling equipment to reduce vibration transmission to air duct structures. Provide inertia bases (type C) for all class 2 and 3 fans and air handling equipment. Provide thrust restraints (type 5) with the same deflection as isolators for all fans and all base-mounted and suspended air-handling equipment operating at 2 in. or more total static pressure. Adjust restraint movement under normal operational static pressures.

Vibration Isolation - Packaged Rooftop Air Conditioning Equipment															
Fan Size	Fan HP, Static Pressure	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
All	All	All	A/D	1	0.25	D	3	0.75	DO NOT ALLOW						1,2,3

Notes:

- Provide restrained isolators, supplemental bracing and snubbers required to account for wind loading conditions.
- Provide curbs where indicated and where manufacturer of equipment requires curb mounting.
- Select isolator deflection so that resonance frequency is 40 percent or less of the lowest normal operating speed of equipment. Add a 1 in. thick pad (type 1) to the base plate of spring isolators (type 3).
- Use of packaged equipment manufacturer internal isolators meeting the above requirements is acceptable. Coordinate with equipment manufacturer. Provide documentation in both equipment submittals and in submittals for this Section.

Vibration Isolation - Ducted Rotating Equipment															
Equipment Type	Airflow (cfm)	RPM	Floor Span												Table Notes
			Slab on Grade			Up to 20 ft			20 to 30 ft			30 to 40 ft			
			Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	Base Type	Isolator Type	Min Defl., (in.)	
Small fans, fan-powered boxes, cabinet heaters, unit heaters	≤600	All	A	3	0.5	A	3	0.5	A	3	0.5	A	3	0.5	
	≥601	All	A	3	0.75	A	3	0.75	A	3	0.75	A	3	0.75	

### **3.7 PIPING SYSTEM VIBRATION ISOLATION**

- A. Vibration isolators for suspended piping:
  - 1. Provide spring hangers for all piping in equipment rooms and up to 50 ft from vibration-isolated equipment and PRV stations. The first three hangers from the equipment shall be provided with the same deflection as the equipment isolators, with a maximum limitation of 2 in. deflection. Remaining hangers shall be spring or combination spring and elastomeric with 0.75 in. deflection. The first two hangers adjacent to the equipment shall be the positioning or pre-compressed type. Provide positioning hangers for all isolated piping 8 in. and larger. Piping over 2 inches in diameter suspended below or within 50 ft of conference rooms, classrooms and auditorium areas shall be hung with isolation hangers.
- B. Vibration isolators for floor-supported piping:
  - 1. Provide vibration isolators for floor supports for piping in equipment rooms to isolate equipment. Isolators shall be selected according to the guidelines for hangers. The first two adjacent floor supports shall be the restrained spring type, with a restraint/blocking feature to prevent load transfer to equipment flanges as the piping is filled or drained. Provide a slide plate where pipe is subjected to large thermal movement (PTFE, graphite, or steel) and shall be installed on top of the isolator. Provide a thermal barrier when rubber products are installed directly beneath steam or hot-water lines.
- C. Vibration isolation for piping riser supports:
  - 1. Provide resilient pipe riser support near to midpoint of riser and provide spring hangers at each floor or structural level to support riser and allow thermal expansion risers.
  - 2. Provide spring hangers for first three hangers connected to branch piping at each level.

**END OF SECTION**

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## **SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Duct labels.
  - 5. Stencils.
  - 6. Valve tags.
  - 7. Warning tags.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

#### **1.4 COORDINATION**

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

### **PART 2 - PRODUCTS**

#### **2.1 EQUIPMENT LABELS**

- A. Metal Labels for Equipment:

1. Material and Thickness: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
  2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
  3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  4. Fasteners: Stainless-steel rivets or self-tapping screws.
  5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
  2. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
  3. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
  4. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  5. Fasteners: Stainless-steel rivets or self-tapping screws.
  6. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## 2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
- B. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- D. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- E. Fasteners: Stainless-steel rivets or self-tapping screws.
- F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- G. Label Content: Include caution and warning information, plus emergency notification instructions.

## 2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches (38 mm)high.

## 2.4 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
- B. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
- C. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
- D. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- E. Fasteners: Stainless-steel rivets or self-tapping screws.
- F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
  - 2. Lettering Size: At least 1-1/2 inches (38 mm)high.

## 2.5 STENCILS

- A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches (32 mm) for ducts; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.
  - 1. Stencil Material: Brass.
  - 2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
  - 3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

## 2.6 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
  - 1. Tag Material: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1. Valve-tag schedule shall be included in operation and maintenance data.

## 2.7 WARNING TAGS

- A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
  - 1. Size: 3 by 5-1/4 inches (75 by 133 mm) minimum.
  - 2. Fasteners: Brass grommet and wire.
  - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
  - 4. Color: Yellow background with black lettering.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### 3.3 PIPE LABEL INSTALLATION

- A. Piping Color-Coding: Comply with ANSI/ASME A13.1.
- B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME A13.1, on each piping system.
  - 1. Identification Paint: Use for contrasting background.
  - 2. Stencil Paint: Use for pipe marking.



- C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
1. Near each valve and control device.
  2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  4. At access doors, manholes, and similar access points that permit view of concealed piping.
  5. Near major equipment items and other points of origination and termination.
  6. At each tee or change in direction.
  7. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
  8. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- D. Pipe Label Color Schedule:
1. Chilled-Water Piping:
    - a. Background Color: Green.
    - b. Letter Color: White.
  2. Heating Water Piping:
    - a. Background Color: Green.
    - b. Letter Color: White.
  3. Refrigerant Piping:
    - a. Background Color: Gray.
    - b. Letter Color: White.
  4. Low-Pressure Steam Piping:
    - a. Background Color: Gray.
    - b. Letter Color: White.
  5. Steam Condensate Piping:
    - a. Background Color: Green.
    - b. Letter Color: White.

### 3.4 DUCT LABEL INSTALLATION

- A. Install plastic-laminated duct labels with permanent adhesive on air ducts in the following color codes:
1. Blue: For cold-air supply ducts.
  2. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
  3. ASME A13.1 Colors and Designs: For hazardous material exhaust (fume hoods and snorkels).
- B. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, may be provided instead of plastic-laminated duct labels, at Installer's option, if lettering larger than 1 inch (25 mm) high is needed for proper identification because of distance from normal location of required identification.

- C. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet (15 m) in each space where ducts are exposed or concealed by removable ceiling system.

### **3.5 VALVE-TAG INSTALLATION**

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  - 1. Valve-Tag Size and Shape:
    - a. Chilled Water: 2 inches (50 mm), round.
    - b. Refrigerant: 2 inches (50 mm), round.
    - c. Hot Water: 2 inches (50 mm), round.
    - d. Low-Pressure Steam: 2 inches (50 mm), round.
    - e. Steam Condensate: 2 inches (50 mm), round.
  - 2. Valve-Tag Color:
    - a. Chilled Water: Green.
    - b. Refrigerant: Natural.
    - c. Hot Water: Green.
    - d. Low-Pressure Steam: Natural.
    - e. Steam Condensate: Natural.
  - 3. Letter Color:
    - a. Chilled Water: Black.
    - b. Refrigerant: Black.
    - c. Hot Water: Black.
    - d. Low-Pressure Steam: Black.
    - e. Steam Condensate: Black.

### **3.6 WARNING-TAG INSTALLATION**

- A. Write required message on, and attach warning tags to, equipment and other items where required.

**END OF SECTION 23 05 53**

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## **SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING FOR HVAC**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Balancing Air Systems:
    - a. Constant-volume air systems.
    - b. Variable-air-volume systems.
  - 2. Balancing Hydronic Piping Systems:
    - a. Constant-flow hydronic systems.
    - b. Variable-flow hydronic systems.

#### **1.3 DEFINITIONS**

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. Certified TAB reports.
- E. Sample report forms.

F. Instrument calibration reports, to include the following:

1. Instrument type and make.
2. Serial number.
3. Application.
4. Dates of use.
5. Dates of calibration.

## 1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB TABB.
2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.

B. TAB Conference: Meet with Owner and Construction Manager on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items:
  - a. The Contract Documents examination report.
  - b. The TAB plan.
  - c. Coordination and cooperation of trades and subcontractors.
  - d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:

1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Construction Manager and Engineer.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

## 1.6 PROJECT CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

## 1.7 COORDINATION

- A. Notice: Provide ten working days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

## PART 2 - PRODUCTS (Not Applicable)

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Division 23, Metal Ducts and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.
  - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible and their controls are connected and functioning.
- K. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

- L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- N. Examine system pumps to ensure absence of entrained air in the suction piping.
- O. Examine operating safety interlocks and controls on HVAC equipment.
- P. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### **3.2 PREPARATION**

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
  1. Permanent electrical-power wiring is complete.
  2. Hydronic systems are filled, clean, and free of air.
  3. Automatic temperature-control systems are operational.
  4. Equipment and duct access doors are securely closed.
  5. Balance, smoke, and fire dampers are open.
  6. Isolating and balancing valves are open and control valves are operational.
  7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  8. Windows and doors can be closed so indicated conditions for system operations can be met.

### **3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING**

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
  1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
  1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
  2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23, Air Duct Accessories.
  3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23, Duct Insulation, Division 23, HVAC Equipment Insulation, and Division 23, HVAC Piping Insulation.
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in English units.

### **3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS**

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Division 23, Metal Ducts.
- M. Simulate dirty filters in AHUs, ERWs and ERUs

### **3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS**

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure total airflow.
    - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
  - 2. Measure fan static pressures as follows to determine actual static pressure:
    - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    - b. Measure static pressure directly at the fan outlet or through the flexible connection.
    - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
    - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
  - 3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.
    - a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
  5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
  6. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
  7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload shall occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure airflow of submain and branch ducts.
    - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
  2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
  3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
  2. Adjust patterns of adjustable outlets for proper distribution without drafts.

### **3.6 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS**

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
  2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for



the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.

3. Measure total system airflow. Adjust to within indicated airflow.
4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
  - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
  - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
8. Record final fan-performance data.

### **3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS**

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
  1. Open all manual valves for maximum flow.
  2. Check liquid level in expansion tank.
  3. Check makeup water-station pressure gage for adequate pressure for highest vent.
  4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
  5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
  6. Set system controls so automatic valves are wide open to heat exchangers.
  7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
  8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

### **3.8 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS**

- A. Measure water flow at pumps. Use the following procedures except for positive-displacement pumps:
  1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage

heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.

- a. If impeller sizes must be adjusted to achieve pump performance, obtain approval from Engineer and comply with requirements in Division 23, Hydronic Pumps.
2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
    - a. Monitor motor performance during procedures and do not operate motors in overload conditions.
  3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
  4. Report flow rates that are not within plus or minus 10 percent of design.
- B. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.
- C. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
- D. Set calibrated balancing valves, if installed, at calculated presettings.
- E. Measure flow at all stations and adjust, where necessary, to obtain first balance.
  1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- F. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- G. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
  1. Determine the balancing station with the highest percentage over indicated flow.
  2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
  3. Record settings and mark balancing devices.
- H. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.
- I. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
- J. Check settings and operation of each safety valve. Record settings.

### **3.9 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS**

- A. Balance systems with automatic two- and three-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

### **3.10 PROCEDURES FOR STEAM SYSTEMS**

- A. Measure and record upstream and downstream pressure of each piece of equipment.
- B. Measure and record upstream and downstream steam pressure of pressure-reducing valves.
- C. Check settings and operation of automatic temperature-control valves, self-contained control valves, and pressure-reducing valves. Record final settings.
- D. Check settings and operation of each safety valve. Record settings.
- E. Verify the operation of each steam trap.

### **3.11 PROCEDURES FOR HEAT EXCHANGERS**

- A. Measure water flow through all circuits.
- B. Adjust water flow to within specified tolerances.
- C. Measure inlet and outlet water temperatures on both sides.
- D. Check settings and operation of safety and relief valves. Record settings.

### **3.12 PROCEDURES FOR MOTORS**

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  - 1. Manufacturer's name, model number, and serial number.
  - 2. Motor horsepower rating.
  - 3. Motor rpm.
  - 4. Efficiency rating.
  - 5. Nameplate and measured voltage, each phase.
  - 6. Nameplate and measured amperage, each phase.
  - 7. Starter thermal-protection-element rating.
- B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

### **3.13 PROCEDURES FOR HEAT-TRANSFER COILS**

- A. Measure, adjust, and record the following data for each water coil:
  - 1. Entering- and leaving-water temperature.
  - 2. Water flow rate.
  - 3. Water pressure drop.
  - 4. Dry-bulb temperature of entering and leaving air.
  - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
  - 6. Airflow.
  - 7. Air pressure drop.
- B. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

### **3.14 PROCEDURES FOR CHILLERS**

- A. Balance water flow through each evaporator to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:
1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
  2. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
  3. Power factor if factory-installed instrumentation is furnished for measuring kilowatts.
  4. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatts.
  5. Capacity: Calculate in tons of cooling.
  6. For air-cooled chillers, verify condenser-fan rotation and record fan and motor data including number of fans and entering- and leaving-air temperatures.

### **3.15 TOLERANCES**

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 5 percent.
  2. Hazardous Exhaust: Plus or minus 5 percent.
  3. Air Outlets and Inlets: Plus or minus 5 percent.
  4. Heating-Water Flow Rate: Plus or minus 10 percent.
  5. Cooling-Water Flow Rate: Plus or minus 10 percent.

### **3.16 REPORTING**

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

### **3.17 FINAL REPORT**

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  2. Include a list of instruments used for procedures, along with proof of calibration.

- B. Final Report Contents: In addition to certified field-report data, include the following:
1. Pump curves.
  2. Fan curves.
  3. Manufacturers' test data.
  4. Field test reports prepared by system and equipment installers.
  5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
  2. Name and address of the TAB contractor.
  3. Project name.
  4. Project location.
  5. Architect's name and address.
  6. Engineer's name and address.
  7. Contractor's name and address.
  8. Report date.
  9. Signature of TAB supervisor who certifies the report.
  10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  11. Summary of contents including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  12. Nomenclature sheets for each item of equipment.
  13. Data for terminal units, including manufacturer's name, type, size, and fittings.
  14. Notes to explain why certain final data in the body of reports vary from indicated values.
  15. Test conditions for fans and pump performance forms including the following:
    - a. Settings for outdoor-, return-, and exhaust-air dampers.
    - b. Conditions of filters.
    - c. Cooling coil, wet- and dry-bulb conditions.
    - d. Face and bypass damper settings at coils.
    - e. Fan drive settings including settings and percentage of maximum pitch diameter.
    - f. Inlet vane settings for variable-air-volume systems.
    - g. Settings for supply-air, static-pressure controller.
    - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
  2. Water and steam flow rates.
  3. Duct, outlet, and inlet sizes.
  4. Pipe and valve sizes and locations.
  5. Terminal units.
  6. Balancing stations.
  7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
    - a. Unit identification.

- b. Location.
- c. Make and type.
- d. Model number and unit size.
- e. Manufacturer's serial number.
- f. Unit arrangement and class.
- g. Discharge arrangement.
- h. Sheave make, size in inches (mm), and bore.
- i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
- j. Number, make, and size of belts.
- k. Number, type, and size of filters.

2. Motor Data:

- a. Motor make, and frame type and size.
- b. Horsepower and rpm.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in inches (mm), and bore.
- f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

3. Test Data (Indicated and Actual Values):

- a. Total air flow rate in cfm (L/s).
- b. Total system static pressure in inches wg (Pa).
- c. Fan rpm.
- d. Discharge static pressure in inches wg (Pa).
- e. Filter static-pressure differential in inches wg (Pa).
- f. Preheat-coil static-pressure differential in inches wg (Pa).
- g. Cooling-coil static-pressure differential in inches wg (Pa).
- h. Heating-coil static-pressure differential in inches wg (Pa).
- i. Outdoor airflow in cfm (L/s).
- j. Return airflow in cfm (L/s).
- k. Outdoor-air damper position.
- l. Return-air damper position.
- m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:

- a. System identification.
- b. Location.
- c. Coil type.
- d. Number of rows.
- e. Fin spacing in fins per inch (mm) o.c.
- f. Make and model number.
- g. Face area in sq. ft. (sq. m).
- h. Tube size in NPS (DN).
- i. Tube and fin materials.
- j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm (L/s).
- b. Average face velocity in fpm (m/s).
- c. Air pressure drop in inches wg (Pa).
- d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
- e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).

- f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
- g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
- h. Water flow rate in gpm (L/s).
- i. Water pressure differential in feet of head or psig (kPa).
- j. Entering-water temperature in deg F (deg C).
- k. Leaving-water temperature in deg F (deg C).
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig (kPa).
- n. Refrigerant suction temperature in deg F (deg C).
- o. Inlet steam pressure in psig (kPa).

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:

- a. System identification.
- b. Location.
- c. Make and type.
- d. Model number and size.
- e. Manufacturer's serial number.
- f. Arrangement and class.
- g. Sheave make, size in inches (mm), and bore.
- h. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

2. Motor Data:

- a. Motor make, and frame type and size.
- b. Horsepower and rpm.
- c. Volts, phase, and hertz.
- d. Full-load amperage and service factor.
- e. Sheave make, size in inches (mm), and bore.
- f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
- g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm (L/s).
- b. Total system static pressure in inches wg (Pa).
- c. Fan rpm.
- d. Discharge static pressure in inches wg (Pa).
- e. Suction static pressure in inches wg (Pa).

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

- a. System and air-handling-unit number.
- b. Location and zone.
- c. Traverse air temperature in deg F (deg C).
- d. Duct static pressure in inches wg (Pa).
- e. Duct size in inches (mm).
- f. Duct area in sq. ft. (sq. m).
- g. Indicated air flow rate in cfm (L/s).
- h. Indicated velocity in fpm (m/s).
- i. Actual air flow rate in cfm (L/s).
- j. Actual average velocity in fpm (m/s).
- k. Barometric pressure in psig (Pa).

I. Air-Terminal-Device Reports:

1. Unit Data:

- a. System and air-handling unit identification.
- b. Location and zone.
- c. Apparatus used for test.
- d. Area served.
- e. Make.
- f. Number from system diagram.
- g. Type and model number.
- h. Size.
- i. Effective area in sq. ft. (sq. m).

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm (L/s).
- b. Air velocity in fpm (m/s).
- c. Preliminary air flow rate as needed in cfm (L/s).
- d. Preliminary velocity as needed in fpm (m/s).
- e. Final air flow rate in cfm (L/s).
- f. Final velocity in fpm (m/s).
- g. Space temperature in deg F (deg C).

J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

- a. System and air-handling-unit identification.
- b. Location and zone.
- c. Room or riser served.
- d. Coil make and size.
- e. Flowmeter type.

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm (L/s).
- b. Entering-water temperature in deg F (deg C).
- c. Leaving-water temperature in deg F (deg C).
- d. Water pressure drop in feet of head or psig (kPa).
- e. Entering-air temperature in deg F (deg C).
- f. Leaving-air temperature in deg F (deg C).

K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Service.
- d. Make and size.
- e. Model number and serial number.
- f. Water flow rate in gpm (L/s).
- g. Water pressure differential in feet of head or psig (kPa).
- h. Required net positive suction head in feet of head or psig (kPa).
- i. Pump rpm.
- j. Impeller diameter in inches (mm).



- k. Motor make and frame size.
- l. Motor horsepower and rpm.
- m. Voltage at each connection.
- n. Amperage for each phase.
- o. Full-load amperage and service factor.
- p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig (kPa).
- b. Pump shutoff pressure in feet of head or psig (kPa).
- c. Actual impeller size in inches (mm).
- d. Full-open flow rate in gpm (L/s).
- e. Full-open pressure in feet of head or psig (kPa).
- f. Final discharge pressure in feet of head or psig (kPa).
- g. Final suction pressure in feet of head or psig (kPa).
- h. Final total pressure in feet of head or psig (kPa).
- i. Final water flow rate in gpm (L/s).
- j. Voltage at each connection.
- k. Amperage for each phase.

L. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

### 3.18 INSPECTIONS

A. Initial Inspection:

- 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
- 2. Check the following for each system:
  - a. Measure airflow of at least 10 percent of air outlets.
  - b. Measure water flow of at least 5 percent of terminals.
  - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
  - d. Verify that balancing devices are marked with final balance position.
  - e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

- 1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Commissioning Authority.
- 2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Commissioning Authority.
- 3. Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total

measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
  5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- C. TAB Work shall be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
  2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.
- D. Prepare test and inspection reports.

### **3.19 ADDITIONAL TESTS**

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

### **END OF SECTION 23 05 93**

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## **SECTION 23 07 00 - HVAC INSULATION**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes insulating the following duct services:
  - 1. Combined Heating and Cooling Ducts – Climate Zones 5, 6, 7 and 8
  - 2. Unconditioned Outside Air Intake Ducts/Plena and Exhaust Relief Duct and Plena Inside the Building Envelope – Climate Zones 2 through 8
  - 3. Unconditioned Outside Air Intake Ducts/Plena and Exhaust/Relief Duct and Plena Outside the Building Envelope – Climate Zones 2 through 8
  - 4. Cooling Coil and Humidifier Drain Pans
  - 5. Cooling System Equipment
  - 6. Heating Hot Water Equipment
  - 7. Steam Equipment
- B. Section includes insulating the following HVAC piping systems
  - 1. Steam/Steam Condensate Return: 0 psig to 15 psig/201 deg F to 250 deg F
  - 2. Steam Pressure Relief: All Pressures/Temperatures
  - 3. Heating Hot Water Systems: 141 deg F to 200 deg F
  - 4. Heating Hot Water Systems: 85 deg F to 140 deg F
  - 5. Cooling and Glycol Energy Recovery Systems 40 deg F to 65 deg F
  - 6. Cooling Coil Condensate Piping, Outdoor Cooling Tower Makeup Water Piping and Equipment Drain Piping
  - 7. Air Conditioning Refrigerant Suction, Hot Gas, Outdoor Liquid Line and Hot Gas Piping
- C. Section includes insulation for Outdoor, Underground Piping (excluding loose fill insulated piping).
- D. Related Sections:
  - 1. Division 33 for underground steam and condensate distribution piping loose fill insulation.
- E. Referenced Standards:
  - 1. ASTM International (ASTM)
  - 2. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE).
  - 3. North American Insulation Manufacturers Association (NAIMA).

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance, thickness, and jackets (both factory- and field-applied if any).
- B. Sustainable Design Submittals

1. Adhesives:
  2. Coatings
  3. Sealants
- C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail application of field-applied jackets.
  2. Detail application at linkages of control devices.
  3. Detail application of protective duct shields, saddles, and inserts at hangers for each type of insulation and hanger.
  4. Detail insulation application at duct elbows, fittings, dampers, specialties and flanges for each type of insulation.
  5. Detail attachment and covering of equipment heat tracing inside insulation.
  6. Detail removable insulation at equipment connections.
  7. Detail field application for each equipment type.
  8. Detail application of protective piping shields, saddles, and inserts at hangers for each type of insulation and hanger.
  9. Detail attachment and covering of piping heat tracing inside insulation.
  10. Detail insulation application at pipe expansion joints for each type of insulation.
  11. Detail insulation application at pipe elbows, fittings, flanges, valves, and specialties for each type of insulation.
  12. Detail removable insulation at piping specialties.
  13. Preformed Pipe Insulation Materials: 12 inches (300 mm) long by NPS 2 (DN 50).
  14. Jacket Materials for Pipe: 12 inches (300 mm) long by NPS 2 (DN 50).

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

#### **1.5 QUALITY ASSURANCE**

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

## 1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23.
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate clearance requirements with equipment Installer for equipment insulation application. Coordinate installation and testing of equipment heat tracing.
- D. Coordinate clearance requirements with piping Installer for piping insulation application. Coordinate installation and testing of piping heat tracing.

## 1.8 SCHEDULING

- A. Schedule insulation application after pressure and leak testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## PART 2 - PRODUCTS

### 2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. *Double-wall, insulated ductwork. Comply with ASTM C1071 and ASTM G21 and G22. Install in locations shown on drawings. Install as per manufacturers guidelines.*
  - 1. *Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following:*
    - a. *McGill AirFlow - Type Rectangular-k27 (2" thick concealed) with "Acoustiline" insulation.*
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials and Type I for tubular materials. For indoor applications insulation meet ASTM E84 Flame Spread and Smoke Developed ratings of 25/50 for thickness required. For duct applications, color shall be selected by the architect from manufacturer standard color options.
  - 1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Aeroflex USA, Inc.; Aerocel.

- b. Armacell LLC; AP Armaflex and Armaflex FS.
  - c. K-Flex USA; Insul-Sheet and Insul-Tube.
- H. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. Pittsburgh Corning Corporation.
  - 2. Block Insulation: ASTM C 552, Type I.
  - 3. Special-Shaped Insulation: ASTM C 552, Type III.
  - 4. Board Insulation: ASTM C 552, Type IV.
  - 5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
  - 6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
  - 7. For duct and plenum applications in mechanical rooms and concealed locations, provide insulation with factory-applied FSK jacket.
  - 8. For duct and plenum applications exposed in occupied spaces, provide insulation with paintable factory-applied ASJ jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 9. Provide insulation with factory-applied ASJ for equipment. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 10. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. CertainTeed Corp.; Commercial Board.
    - b. Fibrex Insulations Inc.; FBX.
    - c. Johns Manville; 800 Series Spin-Glas.
    - d. Knauf Insulation; Earthwool Insulation Board with ECOSE Technology
    - e. Manson Insulation Inc.; AK Board.
    - f. Owens Corning; Fiberglas 700 Series.
- I. Mineral-Fiber (Fiberglass), Preformed Pipe Insulation
- 1. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory and field installed jackets identified in pipe insulation schedules.
  - 2. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Johns Manville; a Berkshire Hathaway company.
    - b. Knauf Insulation.
    - c. Manson Insulation Inc.
    - d. Owens Corning.
- J. Semi-Rigid Mineral-Fiber (Fiberglass) Insulation
- 1. Duct Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Minimum nominal density is 2.5 lb/cu. ft. (40 kg/cu. m). Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 2. Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Minimum nominal density is 2.5 lb/cu. ft. (40 kg/cu. m). Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 3. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:

- a. CertainTeed Corp.; CrimpWrap.
- b. Johns Manville; MicroFlex.
- c. Knauf Insulation; Earthwool Pipe & Tank Insulation with ECOSE Technology.
- d. Knauf Insulation; Kwik-Flex Pipe & Tank Insulation.
- e. Manson Insulation Inc.; AK Flex.
- f. Owens Corning; Fiberglas Pipe and Tank Insulation.

## 2.2 ADHESIVES

- A. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Aeroflex USA, Inc.; Aeroseal Low VOC.
    - b. Armacell LLC; Armaflex 520BLV Adhesive.
    - c. K-Flex USA; 720-LVOC Contact Adhesive.
    - d. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
  
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
    - b. Eagle Bridges - Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
  
- C. ASJ, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  - 1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
    - b. Eagle Bridges - Marathon Industries; 225.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
    - d. Mon-Eco Industries, Inc.; 22-25.
  
- D. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).
  - 1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-97.
    - b. Eagle Bridges - Marathon Industries; 290.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-27.
    - d. Mon-Eco Industries, Inc.; 22-30.
    - e. Vimasco Corporation; 760.
  
- E. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).
  - 1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 81-84.

## 2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates.
1. VOC Content: 300 g/L or less.
  2. Low-Emitting Materials: Mastic coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, 9 mcg/cu. m or 7 ppb, whichever is less, and that of acetaldehyde shall not exceed 9 mcg/cu. m.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
    - b. Vimasco Corporation; 749.
  2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
  4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Encacel.
    - b. Eagle Bridges - Marathon Industries; 570.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 60-95/60-96.
  2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
  3. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
  4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
  5. Color: White.
- D. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
    - b. Eagle Bridges - Marathon Industries; 550.
    - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
    - d. Mon-Eco Industries, Inc.; 55-50.
    - e. Vimasco Corporation; WC-1/WC-5.
  2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
  4. Solids Content: 60 percent by volume and 66 percent by weight.
  5. Color: White.

## 2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.



1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
  - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
  - c. Vimasco Corporation; 713 and 714.
2. Adhesives shall have a VOC content of 250 g/L or less.
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, 9 mcg/cu. m or 7 ppb, whichever is less, and that of acetaldehyde shall not exceed 9 mcg/cu. m.
4. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
5. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
6. Color: White.

## 2.5 SEALANTS

### A. FSK and Metal Jacket Flashing Sealants:

1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
  - b. Eagle Bridges - Marathon Industries; 405.
  - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
  - d. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: Aluminum.
6. Sealant shall have a VOC content of 420 g/L or less.
7. .

### B. ASJ Flashing Sealants and PVC Flashing Sealants:

1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: White.

### C. Joint Sealants:

1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
  - b. Marathon Industries; 405.
  - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
  - d. Mon-Eco Industries, Inc.; 44-05.
  - e. Pittsburgh Corning Corporation; Pittseal 444.

## **2.6 FACTORY-APPLIED JACKETS**

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following or approved equivalent:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I. Permeance of jacket shall not exceed 0.02 perm.
  2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I. Permeance of jacket shall not exceed 0.02 perm.
  3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II. Permeance of jacket shall not exceed 0.02 perm.

## **2.7 FIELD-APPLIED FABRIC-REINFORCING MESH**

- A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm) for covering ducts.
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Chil-Glas No. 5.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for ducts.
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Mast-A-Fab.
    - b. Vimasco Corporation; Elastafab 894.

## **2.8 FIELD-APPLIED CLOTHS**

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

## **2.9 FIELD-APPLIED JACKETS**

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
  2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
  3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- C. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.
  4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

- D. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- E. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) OC and at end joints.
- F. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- G. PVC Jacket: 30 Mil, High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Johns Manville; Zeston.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe.
  2. Adhesive: As recommended by jacket material manufacturer.
  3. Color: White.
  4. Factory-fabricated tank heads and tank side panels.
- H. Metal Jacket:
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
    - b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
    - c. RPR Products, Inc.; Insul-Mate.
  2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    - a. Factory cut and rolled to size.
    - b. Finish and thickness are indicated in field-applied jacket schedules.
    - c. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.
    - d. Factory-Fabricated Fitting Covers:
      - 1) Same material, finish, and thickness as jacket.
      - 2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      - 3) Tee covers.
      - 4) Flange and union covers.
      - 5) End caps.
      - 6) Beveled collars.
      - 7) Valve covers.
      - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- I. Underground Direct-Buried Piping Jacket: 125-mil- (3.2-mm-) thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Pittsburgh Corning Corporation; Pittwrap.
    - b. Polyguard Products, Inc.; Insulrap No Torch 125.

- J. Self-Adhesive Outdoor Jacket: Minimum 12 mil thick, vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; UV resistant, zero permeability with white aluminum-foil facing, impact and tear resistant.
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. Polyguard Products, Inc.; Alumaguard 60.
    - b. Venture Tape Corporation; VentureClad Plus.
  2. Subject to compliance with requirements for thickness, UV resistance, tear resistance and permeability, flexible elastomeric insulation manufacturer cladding may be used for outdoor insulation in lieu of field installed jacketing.

## 2.10 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. ABI, Ideal Tape Division; 428 AWF ASJ.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    - c. Compac Corporation; 104 and 105.
    - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
    - e. Knauf Insulation; EXPERT Tapes: ASJ+ Tape OR ASJ Tape.
  2. Width: minimum 3 inches (75 mm).
  3. Thickness: minimum 11.5 mils (0.29 mm).
  4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. ABI, Ideal Tape Division; 491 AWF FSK.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    - c. Compac Corporation; 110 and 111.
    - d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
    - e. Knauf Insulation; EXPERT Tapes: FSK Tape.
  2. Width: minimum 3 inches (75 mm).
  3. Thickness: minimum 6.5 mils (0.16 mm).
  4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. ABI, Ideal Tape Division; 370 White PVC tape.
    - b. Compac Corporation; 130.
    - c. Venture Tape; 1506 CW NS.
  2. Width: 2 inches (50 mm).
  3. Thickness: 6 mils (0.15 mm).
  4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
  5. Elongation: 500 percent.
  6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. ABI, Ideal Tape Division; 488 AWF.
    - b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    - c. Compac Corporation; 120.
    - d. Venture Tape; 3520 CW.
    - e. Knauf Insulation; EXPERT Tapes: 2 MIL Foil Tape.
  2. Width: minimum 2 inches (50 mm).
  3. Thickness: minimum 3.7 mils (0.093 mm).
  4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
  5. Elongation: 5 percent.
  6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

## 2.11 SECUREMENTS

- A. Bands:
1. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - a. ITW Insulation Systems; Gerrard Strapping and Seals.
    - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
    - c. Wing seals are primarily used for fastening bands together. Closed seals are occasionally used for large, 84-inch- (2130-mm-) diameter applications and where fastening bands are used with springs. Wing seals are reusable; closed seals are not.
  2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 1/2 inch (13 mm) wide with wing seal.
  3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 1/2 inch (13 mm) wide with wing seal.
  4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.
- B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) or 0.135-inch- (3.5-mm-) diameter shank, length to suit depth of insulation indicated.
    - a. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
      - 1) AGM Industries, Inc.; CWP-1.
      - 2) GEMCO; CD.
      - 3) Midwest Fasteners, Inc.; CD.
      - 4) Nelson Stud Welding; TPA, TPC, and TPS.
  2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) or 0.135-inch- (3.5-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
    - a. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
      - 1) AGM Industries, Inc.; CHP-1.
      - 2) GEMCO; Cupped Head Weld Pin.
      - 3) Midwest Fasteners, Inc.; Cupped Head.
      - 4) Nelson Stud Welding; CHP.
  3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:

- a. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - 1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
    - 2) GEMCO; Perforated Base.
    - 3) Midwest Fasteners, Inc.; Spindle.
  - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
  - c. Spindle: Copper- or zinc-coated, low-carbon steel, or Aluminum, or Stainless steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - 1) GEMCO; Nylon Hangers.
    - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
  - b. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
  - c. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:
- a. Available Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the Work include the following or approved equivalent:
    - 1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
    - 2) GEMCO; Peel and Press.
    - 3) Midwest Fasteners, Inc.; Self Stick.
  - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
  - c. Spindle: Copper- or zinc-coated, low-carbon steel, or Aluminum, or Stainless steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, galvanized-steel, or aluminum, or stainless-steel sheet matching hanger materials, with beveled edge sized to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
- a. Available Manufacturers: Subject to compliance with requirements,:
    - 1) AGM Industries, Inc.; RC-150.
    - 2) GEMCO; R-150.
    - 3) Midwest Fasteners, Inc.; WA-150.
    - 4) Nelson Stud Welding; Speed Clips.
  - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
  - a. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - 1) GEMCO.
    - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.
- D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.
  1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. C and F Wire.

## **2.12 CORNER ANGLES**

- A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- C. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  1. Verify that systems and equipment to be insulated have been tested and are free of defects.
  2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Duct Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application including dirt, scale, oil, rust and other foreign matter.
- B. Equipment Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- C. Piping Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

- D. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- E. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

### **3.3 GENERAL INSTALLATION REQUIREMENTS**

- A. Protect insulation from exposure to moisture prior to and after installation. All insulation other than flexible elastomeric that becomes wet shall be replaced at no cost to the project.
- B. Install insulation after systems have been tested, proved tight. Remove dirt, scale, oil, rust and other foreign matter prior to installation of insulation.
- C. Install insulation, mastics, adhesives, coatings, covers, weather-protection and other work in accordance with manufacturer's recommendations. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic. Leakage in vapor barrier or voids in insulation will not be accepted.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied non-self-sealing jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) OC
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at manufacturer recommended spacing but space no further than 4 inches (100 mm) OC
    - a. For below ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.



- L. Install insulation with self-sealing factory-applied jackets as follows:
  - 1. Locate all longitudinal pipe insulation jacketing laps in least visible location.
  - 2. Draw jacket tight and smooth.
  - 3. For proper sealing, seal lap joints with reasonable pressure being applied with a plastic squeegee or sealing tool.
  - 4. Vapor seal all circumferential joints with factory furnished matching pressure sensitive butt strips installed with reasonable pressure being applied with a plastic squeegee or sealing tool.
  
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
  
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
  
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
  
- P. Insulate flex connections to same thickness as material as adjoining system
  
- Q. Duct Insulation Requirements:
  - 1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
  - 2. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
  - 3. Insulate standing seams with same material and thickness as duct.
  - 4. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
  - 5. Insulate flex connections to same thickness as material as adjoining ductwork.
  
- R. Equipment Insulation Requirements:
  - 1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
  - 2. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.
  - 3. For above ambient services, do not install insulation to the following:
    - a. Vibration-control devices.
    - b. Testing agency labels and stamps.
    - c. Nameplates and data plates.
    - d. Manholes.
    - e. Handholes.
    - f. Cleanouts.
  
- S. Piping Insulation Requirements:
  - 1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
  - 2. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
  - 3. For piping systems operating below 60 deg F, seal ends of pipe insulation onto the jacket and seal insulation onto the pipe with approved fire retardant vapor barrier mastic, at flanges, valves and fittings and at intervals of no more than every fourth section of pre-formed insulation or 20 feet on continuous runs of piping whichever is less.
  - 4. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
  - 5. Insulate flex connections to same thickness as material as adjoining piping.
  - 6. For above ambient services, do not install insulation to the following:
    - a. Vibration-control devices.

- b. Testing agency labels and stamps.
- c. Nameplates and data plates.
- d. Manholes.
- e. Handholes.
- f. Cleanouts.

### 3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
  - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
  - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire-Rated): Install insulation continuously through walls and partitions.
- E. Ductwork Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).
  - 1. Comply with requirements in Division 07 for firestopping and fire-resistive joint sealers.
- F. Duct Insulation Installation at Floor Penetrations:
  - 1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
  - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07.
- G. Piping Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
  - 1. Comply with requirements in Division 07 for firestopping and fire-resistive joint sealers.
- H. Piping Insulation Installation at Floor Penetrations:
  - 1. Pipe: Install insulation continuously through floor penetrations.
  - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07.

### 3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Flanges:
  - 1. Install pipe insulation to outer diameter of pipe flange.
  - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
  - 4. Secure insulation to flanges and seal seams with manufacturer recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
  - 1. Install mitered sections of pipe insulation.
  - 2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
  - 1. Install preformed valve covers manufactured of same material as pipe insulation when available.
  - 2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  - 3. Install insulation to flanges as specified for flange insulation application.
- E. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.6 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
  - 1. Apply adhesives according to manufacturer's recommended coverage rates per unit area recommended by the insulation manufacturer but no less than for 50 percent coverage of duct and plenum surfaces.
  - 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  - 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) OC
    - b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) OC each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not over compress insulation during installation. Maximum allowable compressions shall be as recommended by the insulation manufacturer.
    - e. Impale insulation over pins and attach speed washers.
    - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  - 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment.

- Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) OC Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
  - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 20-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).
5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) OC
  6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
  7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) OC
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area recommended by the insulation manufacturer but no less than for 50 percent coverage of duct and plenum surfaces.
  2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions. Horizontal rectangular ducts can omit adhesive from top horizontal surface.
  3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) OC.
    - b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16 inches (400 mm) OC each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not over-compress insulation during installation.
    - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1 inch (25 mm) OC Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    - b. Install vapor stops for ductwork and plenums operating below 50 deg F (10 deg C) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).
  5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.

6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch- (150-mm-) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) OC
- C. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  3. For insulation with factory-applied jackets on above-ambient surfaces, secure using the self-seal system per manufacturer's recommendations or for non-self-seal systems, secure laps with outward-clinched staples at 6 inches (150 mm) OC
  4. For insulation with factory-applied jackets on below-ambient surfaces, secure using the self-seal systems per manufacturer's recommendations, or for non-self-seal systems, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- D. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
  4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
- E. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
  2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.
- F. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed sections of same material as straight segments of pipe insulation when available.
  2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
  3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  4. Install insulation to flanges as specified for flange insulation application.

### **3.7 FIELD-APPLIED JACKET INSTALLATION**

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
  2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
  3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.
  4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.

5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer recommended adhesive.
1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) OC and at end joints.

### **3.8 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION**

- A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area recommended by the insulation manufacturer but no less than for 50 percent coverage of tank and vessel surfaces.
  2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
  3. Protect exposed corners with secured corner angles.
  4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
    - a. Do not weld anchor pins to ASME-labeled pressure vessels.
    - b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) OC in both directions.
    - d. Do not over-compress insulation during installation.
    - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    - f. Impale insulation over anchor pins and attach speed washers.
    - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
  5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
  6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch pre-stressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) OC. Install a wire ring around each end and around outer periphery of center openings, and stretch pre-stressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) OC. Use this network for securing insulation with tie wire or bands.
  7. Stagger joints between insulation layers at least 3 inches (75 mm).
  8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
  9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
  10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
  - 1. Apply manufacturer recommended coverage of adhesive but no less than 50% to surface with manufacturer's recommended adhesive.
  - 2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
  - 1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch- (10-mm-) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
  - 2. Fabricate boxes from galvanized steel for indoor pumps and aluminum or stainless steel, at least 0.050 inch (1.3 mm) thick.
  - 3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

### **3.9 GENERAL PIPE INSULATION INSTALLATION**

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
  - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  - 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
  - 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  - 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  - 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  - 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers. Installation shall conform to the following:
  - 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  - 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  - 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  - 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  - 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### **3.10 INSTALLATION OF CALCIUM SILICATE INSULATION**

- A. Insulation Installation on Boiler Breechings, Flues and Connectors:
  - 1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation material.
  - 2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
  - 3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.
- B. Insulation Installation on Straight Pipes and Tubes:
  - 1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.
  - 2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
  - 3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.
- C. Insulation Installation on Pipe Flanges:
  - 1. Install preformed pipe insulation to outer diameter of pipe flange.
  - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
  - 4. Finish flange insulation same as pipe insulation.



- D. Insulation Installation on Pipe Fittings and Elbows:
  - 1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
  - 2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
  - 3. Finish fittings insulation same as pipe insulation.
- E. Insulation Installation on Valves and Pipe Specialties:
  - 1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  - 2. Install insulation to flanges as specified for flange insulation application.
  - 3. Finish valve and specialty insulation same as pipe insulation.

### **3.11 INSTALLATION OF CELLULAR-GLASS INSULATION**

- A. Insulation Installation on Straight Pipes and Tubes:
  - 1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  - 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  - 3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches (150 mm) OC
  - 4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
  - 1. Install preformed pipe insulation to outer diameter of pipe flange.
  - 2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  - 3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
  - 4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.
- C. Insulation Installation on Pipe Fittings and Elbows:
  - 1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
  - 2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
- D. Insulation Installation on Valves and Pipe Specialties:
  - 1. Install preformed sections of cellular-glass insulation to valve body.
  - 2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  - 3. Install insulation to flanges as specified for flange insulation application.

### **3.12 FINISHES**

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 for exterior and interior painting.
  - 1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.

- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating. Coating for outdoor insulation shall be UV resistant and waterproof.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

### **3.13 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
  - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to two location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
  - 2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to two location(s) for each type of equipment defined in the Part 3. For large equipment, remove only a portion adequate to determine compliance.
  - 3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

### **3.14 DUCT INSULATION SCHEDULE General**

- A. Items Not Insulated:
  - 1. Fibrous-glass ducts.
  - 2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA scheduled values below.
  - 3. Factory-insulated flexible ducts.
  - 4. Factory-insulated plenums and casings.
  - 5. Vibration-control devices.
  - 6. Factory-insulated access panels and doors.

### **3.15 DUCT AND PLENUM INSULATION SCHEDULE**

- A. Provide insulation materials and thicknesses identified below. If more than one material is listed for a duct location, selection from materials listed is Division 23 option.
- B. Duct Insulation Schedules:
  - 1. Where application of rigid versus blanket insulation on components such as coils and supply fans is to be based on the height of a component, height shall be determined based on the bottom of the component listed. Extend applicable insulation over the entire component

before transitioning to alternate material. For ductwork, transition from blanket to rigid insulation shall occur no lower than height listed.

2. Exposed ductwork between air volume terminal or local heating or cooling unit mounted within the space served and associated diffusers or registers does not require external insulation. Where air volume terminal or local heating or cooling unit are mounted outside the space served, insulate ductwork between the air volume terminal or local heating or cooling unit and the wall of the space served.

Combined Heating and Cooling Supply, Return and Heat/Energy Recovery System Exhaust Ducts Climate Zone 5, 6, 7 and 8						
Duct Location	Minimum As-Installed R-Value	Insulation Type	Minimum Thickness (inches)	Minimum Density (lb/cu.ft)	Factory Applied Jacket	Field Applied Jacket
<i>All exposed supply and return ductwork. See plans.</i>	R-7.4	<i>Double wall "Acousti-Line" - McGill</i>	2.0	N/A	N/A	N/A
All ductwork, plena, duct mounted coils and supply fans exterior to building envelope. For rectangular and flat oval ductwork taper top insulation to prevent water accumulation by increasing thickness 1/8" per foot up from minimum listed to high point for drainage.	R-12.0	Rigid Mineral-Fiber Board	3.0	6.0	FSK	Self-Adhesive Outdoor Jacket
		Semi-Rigid Mineral-Fiber Board	3.0	1.5	FSK	
		Flexible Elastomeric	3.0	N/A	N/A	
All concealed ductwork, plena, duct mounted coils and supply fans in unconditioned spaces including shafts, non-plenum return ceiling cavities and crawlspaces (ventilated and non-ventilated) and all exposed ductwork, plena, duct mounted coils and supply fans in mechanical rooms located more than 10 feet above finished floor.	R-6.0	Mineral-Fiber Blanket	2.0	1.0	FSK	N/A
		Semi-Rigid Mineral-Fiber Board	1.5	1.5	FSK	N/A
All exposed ductwork, plena, duct mounted coils and supply fans in mechanical rooms 10 feet or less above finished floor.	R-6.0	Rigid Mineral-Fiber Board	1.5	6.0	FSK	N/A
Concealed supply ductwork, plena, duct mounted coils and supply fans in indirectly conditioned spaces including return air plenums with or without exposed roofs above.	R-1.9	Mineral-Fiber Blanket	1.5	0.75	FSK	N/A
		Semi-Rigid Mineral-Fiber Board	1.5	1.5	FSK	N/A
		Flexible Elastomeric	0.5	N/A	N/A	N/A
All round ductwork and supply fans in mechanical rooms and all round ductwork in exposed location below 10 feet above finished floor.	R-6.0	Semi-Rigid Mineral-Fiber Board	1.5	1.5	FSK	N/A
Backs of air outlets and outlet plenums with face	R-2.0	Mineral-Fiber Blanket	1.5	0.75	FSK	N/A

Combined Heating and Cooling Supply, Return and Heat/Energy Recovery System Exhaust Ducts Climate Zone 5, 6, 7 and 8						
Duct Location	Minimum As-Installed R-Value	Insulation Type	Minimum Thickness (inches)	Minimum Density (lb/cu.ft)	Factory Applied Jacket	Field Applied Jacket
<i>All exposed supply and return ductwork. See plans.</i>	<i>R-7.4</i>	<i>Double wall "Acousti-Line" - McGill</i>	<i>2.0</i>	<i>N/A</i>	<i>N/A</i>	<i>N/A</i>
area larger than 5 square feet that are exposed to unconditioned and indirectly conditioned spaces.		Flexible Elastomeric	0.5	N/A	N/A	N/A
All exposed supply ductwork passing through occupied spaces from heating and cooling unit or shaft to the supply air terminal box inlet or wall of space served and ductwork between the terminal box and the wall of space served.	R-1.9	Rigid Mineral-Fiber Board	1.5	3.0	ASJ	N/A
		Semi-Rigid Mineral-Fiber Board	1.5	1.5	ASJ	N/A
		Flexible Elastomeric	0.5	N/A	N/A	N/A

Unconditioned Outside Air Intake Ducts/Plena and Exhaust/Relief Duct/Plena Inside Building Envelope Climate Zones 2 Through 8						
Duct Location	Minimum As-Installed R-Value	Insulation Type	Minimum Thickness (inches)	Minimum Density (lb/cu.ft)	Factory Applied Jacket	Field Applied Jacket
For outside air intakes, all ductwork and plena between the building envelope and the first system heating coil, cooling coil or air handling unit connection.	R-12.0	Rigid Mineral-Fiber Board	3.0	6.0	FSK	N/A
		Semi-Rigid Mineral-Fiber Board	3.0	1.5	FSK	
For exhaust/relief ducts and plena, all ductwork and plena between the building envelope and first system isolation damper.	R-12.0	Rigid Mineral-Fiber Board	3.0	6.0	FSK	N/A
		Semi-Rigid Mineral-Fiber Board	3.0	1.5	FSK	

Unconditioned Outside Air Intake Ducts/Plena and Exhaust/Relief Duct/Plena Outside Building Envelope Climate Zones 2 Through 8						
Duct Location	Minimum As-Installed R-Value	Insulation Type	Minimum Thickness (inches)	Minimum Density (lb/cu.ft)	Factory Applied Jacket	Field Applied Jacket
For outside air intakes where isolation damper between indoors and outdoors is located outdoors, all rectangular ductwork and plena between the isolation damper and building envelope penetration.	R-12.0	Rigid Mineral-Fiber Board	3.0	6.0	FSK	N/A
		Semi-Rigid Mineral-Fiber Board	3.0	1.5	FSK	
For exhaust/ relief ducts and plena where isolation damper between indoors and outdoors is located outdoors, all rectangular ductwork and plena between the isolation damper and the building envelope.	R-12.0	Rigid Mineral-Fiber Board	3.0	6.0	FSK	N/A
		Semi-Rigid Mineral-Fiber Board	3.0	1.5	FSK	

### 3.16 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option. Refer to duct insulation tables for supply fan and duct mounted coils requirements.
- B. Insulate indoor and outdoor equipment that is not factory insulated.

Cooling Coil and Humidifier Drain Pans		
Insulation Type	Minimum Thickness (inch)	Factory Applied Jacket
Rigid Mineral-Fiber Board: Minimum Density = 6 lb/cu.ft	1	FSK
Semi-Rigid Mineral-Fiber Board: Minimum Density = 1.5 lb/cu.ft		
Flexible Elastomeric		N/A

Cooling System Equipment Insulation Schedule					
Equipment Type	Insulation Type	Indoor - Minimum Thickness (inch)	Outdoor - Minimum Thickness (inch)	Factory Applied Jacket	Field Applied Jacket – Outdoor Only
Chilled-water, condenser water and heat-recovery pumps	Rigid Mineral-Fiber Board: Minimum Density = 6 lb/cu.ft	1	2	FSK	Self-Adhesive Outdoor Jacket
Chilled-water, condenser water and heat recovery air-separators	Semi-Rigid Mineral-Fiber Board: Minimum Density = 1.5 lb/cu.ft				
Piping system filter-housings	Flexible Elastomeric			N/A	Glass-Fiber Cloth
Chillers: Cold surfaces on chillers, including, but not limited to, evaporator bundles, condenser bundles, heat-recovery bundles, suction piping, compressor inlets, tube sheets, water boxes, and nozzles	Rigid Mineral-Fiber Board: Minimum Density = 6 lb/cu.ft	2	4	FSK	Self-Adhesive Outdoor Jacket
	Semi-Rigid Mineral-Fiber Board: Minimum Density = 1.5 lb/cu.ft				
Heat-exchanger (water-to-water for cooling service)				N/A	Glass-Fiber Cloth
Cooling System Tanks: Chilled-water, condenser-water, thermal storage (brine, water, ice) and heat recovery	Flexible Elastomeric			N/A	Glass-Fiber Cloth

Heating Hot Water Equipment Insulation Schedule					
Equipment Type	Insulation Type	Indoor - Minimum Thickness (inch)	Outdoor - Minimum Thickness (inch)	Factory Applied Jacket	Field Applied Jacket – Outdoor Only
Heating-hot-water pumps	Rigid Mineral-Fiber Board: Minimum Density = 6 lb/cu.ft	1	2	FSK	Self-Adhesive Outdoor Jacket
Heating-hot-water air-separator	Semi-Rigid Mineral-Fiber Board:				
Piping system filter-housing	Minimum Density = 1.5 lb/cu.ft				
Heat-exchanger (water-to-water for heating service)	Rigid Mineral-Fiber Board: Minimum Density = 6 lb/cu.ft	2	4	FSK	Self-Adhesive Outdoor Jacket
Heating-hot-water system tanks, heat recovery tanks and thermal storage tanks	Semi-Rigid Mineral-Fiber Board: Minimum Density = 1.5 lb/cu.ft				
Radiant Heating Panel and Exposed Bottom Surface of Radiant Floor Heating. Adjacent building envelope insulation counts towards the specified minimum R-Value.	Mineral-Fiber Blanket: Minimum Density = 0.75 lb/cu.ft, Minimum R-Value = 3.5.	1.5	N/A	N/A	N/A

Steam Equipment Insulation Schedule					
Equipment Type	Insulation Type	Indoor - Minimum Thickness (inch)	Outdoor - Minimum Thickness (inch)	Factory Applied Jacket	Field Applied Jacket – Outdoor Only
Steam-to-hot-water converter	Rigid Mineral-Fiber Board: Minimum Density = 6 lb/cu.ft	1	2	FSK	Self-Adhesive Outdoor Jacket
	Semi-Rigid Mineral-Fiber Board: Minimum Density = 1.5 lb/cu.ft				
Steam condensate pump and boiler feedwater pump	Rigid Mineral-Fiber Board: Minimum Density = 6 lb/cu.ft	2	4	FSK	Self-Adhesive Outdoor Jacket
Steam flash-tank, flash-separator, moisture-separator, and blow-off-tank	Semi-Rigid Mineral-Fiber Board: Minimum Density = 1.5 lb/cu.ft				

### 3.17 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
1. Drainage piping located in crawl spaces.
  2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.



### **3.18 PIPING INSULATION SCHEDULE**

- A. Provide insulation materials and thicknesses scheduled for each system type and pressure/temperature range. If more than one material is listed for a system, selection from materials listed is Division 23 option.
- B. For dual temperature systems (heating and cooling), provide thickness equal to greater of heating or cooling scheduled value. Dual temperature piping shall also meet all vapor barrier requirements for cooling insulation (perm rating).
- C. Insulation for pre-insulated piping shall meet all specified requirements.
- D. Insulate piping operating at temperatures below 40 deg F and systems operating between 40 deg F to 65 deg F in accordance with NAIMA Guide to Insulating Chilled Water Piping Systems with Mineral Fiber Pipe Insulation. Comply with all recommendations including but not limited to the requirement for vapor dams every fourth section of insulation.

E. Pipe Insulation Schedules:

Steam/Steam Condensate Return (including all hot piping associated with a steam boiler system): 0 psig to 15 psig/201 deg F to 250 deg F						
Insulation Conductivity Btu-in/hr-deg F-SF at Mean Temp (deg F)	Insulation Type	Pipe Size (inch)	Indoor - Minimum Thickness (inch)	Outdoor - Minimum Thickness (inch)	Factory Applied Jacket	Field Applied Jacket
0.27 to 0.30 at 150	Mineral Fiber (Fiberglass) Preformed Pipe, Type I or Type II or Pipe and Tank Insulation for 14" and Larger Pipe Size	Less than 1	2.5	4.0	ASJ or ASJ-SSL	Indoor: PVC for exposed piping in mechanical rooms when mounted 10 feet or lower above finished floor  Outdoor: Aluminum with Moisture Barrier
		1 to Less than 1.5	2.5	4.0		
		1.5 to Less than 4	2.5	4.0		
		4 to Less than 8	3.0	4.0		
		8 and Larger	3.0	4.0		

Steam Pressure Relief: All Pressures/Temperatures						
Insulation Conductivity Btu-in/hr-deg F-SF at Mean Temp (deg F)	Insulation Type	Pipe Size (inch)	Indoor - Minimum Thickness (inch)	Outdoor - Minimum Thickness (inch)	Factory Applied Jacket	Field Applied Jacket
0.27 to 0.30 at 150  Applies to piping 24" NPS or smaller, fiberglass insulation with ASJ and pressures up to 200 psig	Mineral Fiber (Fiberglass) Preformed Pipe, Type I or Type II or Pipe and Tank Insulation for 14" and Larger Pipe Size	Less than 1	0.75	N/A	ASJ or ASJ-SSL	Indoor: PVC for exposed piping in mechanical rooms when mounted 10 feet or lower above finished floor  Outdoor: Aluminum with Moisture Barrier
		1 to Less than 1.5	0.75	N/A		
		1.5 to Less than 4"	0.75	N/A		
		4 to Less than 8	0.75	N/A		
		8 and Larger	0.75	N/A		

Heating Hot Water Systems: 141 deg F to 200 deg F						
Insulation Conductivity Btu-in/hr-deg F-SF at Mean Temp (deg F)	Insulation Type	Pipe Size (inch)	Indoor - Minimum Thickness (inch)	Outdoor - Minimum Thickness (inch)	Factory Applied Jacket	Field Applied Jacket
0.25 to 0.29 at 125	Mineral Fiber (Fiberglass) Preformed Pipe, Type I or Pipe and Tank Insulation for 14" and Larger Pipe Size	Less than 1	1.5	3.0	ASJ or ASJ-SSL	Indoor: PVC for exposed piping in mechanical rooms when mounted 10 feet or lower above finished floor  Outdoor: Aluminum with Moisture Barrier
		1 to Less than 1.5	1.5	3.0		
		1.5 to Less than 4	2.0	4.0		
		4 to Less than 8	2.0	4.0		
		8 and Larger	2.0	4.0		

Heating Hot Water Systems: 85 deg F to 140 deg F						
Insulation Conductivity Btu-in/hr-deg F-SF at Mean Temp (deg F)	Insulation Type	Pipe Size (inch)	Indoor - Minimum Thickness (inch)	Outdoor - Minimum Thickness (inch)	Factory Applied Jacket	Field Applied Jacket
0.22 to 0.28 at 100	Mineral Fiber (Fiberglass) Preformed Pipe, Type I or Pipe and Tank Insulation for 14" and Larger Pipe Size	Less than 1	1.0	2.0	ASJ or ASJ-SSL	Indoor: PVC for exposed piping in mechanical rooms when mounted 10 feet or lower above finished floor  Outdoor: Aluminum with Moisture Barrier
		1 to Less than 1.5	1.0	2.0		
		1.5" to Less than 4	1.5	3.0		
		4 to Less than 8	1.5	3.0		
		8 and Larger	1.5	3.0		

Cooling and Glycol Energy Recovery Systems: 40 deg F to 65 deg F Applies to the Following Systems: Chilled Water, Refrigerant, Brine, Glycol Energy Recovery Systems (winter mode), Cooling Tower Piping When Used for Winter Free Cooling and All Outdoor Heat Traced Piping						
Insulation Conductivity Btu-in/hr-deg F-SF at Mean Temp (deg F)	Insulation Type	Pipe Size (inch)	Indoor - Minimum Thickness (inch)	Outdoor - Minimum Thickness (inch)	Factory Applied Jacket	Field Applied Jacket
0.21 to 0.27 at 75	Mineral Fiber (Fiberglass) Preformed Pipe, Type I or Pipe and Tank Insulation for 14" and Larger Pipe Size	Less than 1	1.5	3.0	ASJ or ASJ-SSL	Indoor: PVC for exposed piping in mechanical rooms when mounted 10 feet or lower above finished floor  Outdoor: Aluminum with Moisture Barrier
		1 to Less than 1.5	1.5	3.0		
		1.5 to Less than 4	1.5	3.0		
		4 to Less than 8	1.5	3.0		
		8 and Larger	1.5	3.0		

Cooling Coil Condensate Piping, Outdoor Cooling Tower Makeup Water Piping and Equipment Drain Piping: All						
Insulation Conductivity Btu-in/hr-deg F-SF at Mean Temp (deg F)	Insulation Type	Pipe Size (inch)	Indoor - Minimum Thickness (inch)	Outdoor - Minimum Thickness (inch)	Factory Applied Jacket	Field Applied Jacket
Mineral Fiber with Conductivity = 0.20 to 0.26 at 50  Flexible Elastomeric with Conductivity = 0.26 at 0 (2013 ASHRAE Fundamentals Handbook)	Mineral Fiber (Fiberglass) Preformed Pipe, Type I or Flexible Elastomeric	Less than 1	0.75	2.0	ASJ or ASJ-SSL for Mineral Fiber  N/A for Flexible Elastomeric	Indoor Mineral Fiber: PVC for exposed piping in mechanical rooms when mounted 10 feet or lower above finished floor.  Indoor Flexible Elastomeric: N/A  Outdoor Mineral Fiber: Aluminum with Moisture Barrier  Outdoor Flexible Elastomeric: Glass-Fiber Cloth
		1 to Less than 1.5	0.75	2.0		
		1.5 to Less than 4	0.75	2.0		
		4 to Less than 8	0.75	2.0		
		8 and Larger	0.75	2.0		

Air Conditioning System Refrigerant Suction, Outdoor Liquid Line and Hot Gas Piping: All Minimum Pipe Operating Temperature 40 deg F						
Insulation Conductivity Btu-in/hr-deg F-SF at Mean Temp (deg F)	Insulation Type	Pipe Size (inch)	Indoor - Minimum Thickness (inch)	Outdoor - Minimum Thickness (inch)	Factory Applied Jacket	Field Applied Jacket
0.26 at 0 (2013 ASHRAE Fundamentals Handbook)	Flexible Elastomeric	Less than 3	1.5	1.5	N/A	Indoor: N/A Outdoor: Glass-Fiber Cloth
		3 to 4	1.5	2.0		
		6 to 8	1.5	2.5		
		10 to 14	1.5	3.0		
		16 to 24	1.5	3.5		

### 3.19 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

- A. This section does not apply where other Division 23 sections require the installation of loose-fill insulation for underground piping.
- B. Schedule of field installed insulation for underground piping:

System Served	Insulation Type	Minimum Insulation Thickness (inches)
Chilled Water, Condenser Water, Heating Hot Water 200 deg F and Below, Dual Temperature (Heating/Cooling) Piping, All Sizes	Cellular Glass with Underground Direct-Buried Piping Jacket	2.0
Heating Hot Water All Sizes Above 200 deg F, All Sizes		3.0
Steam and Steam Condensate All Sizes, 140 psig/350 deg F and Below, All Sizes		4.0
Steam and Steam Condensate All Sizes, 141 psig and Above/351 deg F and Above, All Sizes		5.0
Heated Fuel Oil Piping, All Sizes		2.0

### 3.20 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Refer to Duct, Plenum, Equipment and Pipe insulation schedules for outdoor field applied jacketing requirements. If more than one material is listed, selection from materials listed is Contractor's option.
- C. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

**END OF SECTION**

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## **SECTION 23 08 00 - COMMISSIONING OF HVAC**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.
- B. Related Sections:
  - 1. Division 01 "General Commissioning Requirements" for general commissioning process requirements.

#### **1.3 DEFINITIONS**

- A. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- B. CxA: Commissioning Authority.
- C. HVAC&R: Heating, Ventilating, Air Conditioning, and Refrigeration.
- D. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Certificates of readiness.
- B. Certificates of completion of installation, prestart, and startup activities.

#### **1.5 ALLOWANCES**

- A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Division 01 "Allowances."

## **1.6 UNIT PRICES**

- A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Division 01 "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

## **1.7 CONTRACTOR'S RESPONSIBILITIES**

- A. Perform commissioning tests at the direction of the CxA.
- B. Attend construction phase controls coordination meeting.
- C. Attend testing, adjusting, and balancing review and coordination meeting.
- D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.
- E. Provide information requested by the CxA for final commissioning documentation.
- F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

## **1.8 CxA'S RESPONSIBILITIES**

- A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.
- B. Direct commissioning testing.
- C. Verify testing, adjusting, and balancing of Work are complete.
- D. Provide test data, inspection reports, and certificates in Systems Manual.

## **1.9 COMMISSIONING DOCUMENTATION**

- A. Provide the following information to the CxA for inclusion in the commissioning plan:
  - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.
  - 2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
  - 3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment, and components to be verified and tested.
  - 4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.
  - 5. Certificate of readiness certifying that HVAC&R systems, subsystems, equipment, and associated controls are ready for testing.
  - 6. Test and inspection reports and certificates.
  - 7. Corrective action documents.
  - 8. Verification of testing, adjusting, and balancing reports.

## **PART 2 - PRODUCTS (Not Used)**

## **PART 3 - EXECUTION**

### **3.1 TESTING PREPARATION**

- A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

### **3.2 TESTING AND BALANCING VERIFICATION**

- A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least 10 days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
  - 1. The CxA will notify testing and balancing Contractor 10 days in advance of the date of field verification. Notice will not include data points to be verified.
  - 2. The testing and balancing Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.
  - 3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.
  - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.



### **3.3 GENERAL TESTING REQUIREMENTS**

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the HVAC&R Contractor, testing and balancing Contractor, and HVAC&R Instrumentation and Control Contractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- E. Tests will be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

### **3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES**

- A. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23, Instrumentation and Control for HVAC and Division 23, Sequence and Operations for HVAC Controls. Assist the CxA with preparation of testing plans.
- B. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in HVAC piping Sections. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide cleaning, flushing, testing, and treating plan and final reports to the CxA. Plan shall include the following:
  - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
  - 2. Description of equipment for flushing operations.
  - 3. Minimum flushing water velocity.
  - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

- C. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of steam and hot-water systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- D. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.
- E. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.
- F. House air handling unit (supply and return air), exhaust system, hot water system, chilled water system, low pressure steam supply, low pressure steam condensate, and pumped steam condensate return.

**END OF SECTION**

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## **SECTION 23 82 19 - FAN COIL UNITS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes fan-coil units and accessories.

#### **1.3 DEFINITIONS**

- A. BAS: Building automation system.

#### **1.4 SUBMITTALS**

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- 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. Wiring Diagrams: Power, signal, and control wiring.
- C. Coordination Drawings: Floor plans, reflected ceiling plans, 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. Ceiling suspension components.
  - 2. Structural members to which fan-coil units shall be attached.
  - 3. Method of attaching hangers to building structure.
  - 4. Size and location of initial access modules for acoustical tile.
  - 5. Items penetrating finished ceiling, including the following:
    - a. Lighting fixtures.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
  - 6. Perimeter moldings for exposed or partially exposed cabinets.
- D. Samples for Initial Selection: For units with factory-applied color finishes.
- E. Field quality-control test reports.

- F. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, Operation and Maintenance Data, include the following:
  - 1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.
- G. Warranty: Special warranty specified in this Section.

## **1.5 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. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

## **1.6 COORDINATION**

- A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate duct collar size and configuration to conform to the ductwork distribution shown on the plans and mixing box as scheduled.

## **1.7 WARRANTY**

- A. Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components that fail in materials or workmanship within specified warranty period.

## **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. Fan-Coil-Unit Filters: Furnish one (1) spare filter for each unit installed.
  - 2. Fan Belts: Furnish one (1) spare fan belts for each belt drive unit installed.

## **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 the Fan-Coil-Unit Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified or approved equivalent.

## 2.2 FAN COIL UNITS

- A. Manufacturers subject to compliance with requirements, provide products by one of the following or approved equivalent:
  1. Environmental Technologies
  2. Airtherm
  3. Trane
  4. Carrier Corporation
- B. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.
- C. Unit Construction: All unit chassis shall be fabricated of heavy gauge galvanized steel panels able to meet 125 hour salt spray test per ASTM B-117
- D. Unit Configuration: Fan coil unit shall be a Draw through type unit
- E. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color as selected by Architect.
  1. Wall recessed Vertical Unit Front Panels: Removable, steel, with steel discharge and return grille and channel-formed edges, cam fasteners, and insulation on back of panel.
  2. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; Provide concealed and exposed units with duct collar connections for supply and return where required - see Drawings.
  3. Color for vertical units as selected by Architect from manufacturer's custom colors. Return grille shall be large enough to provide maintenance access to fan-coil unit. Provide extensions for supply and return grilles to account for furred out walls.
  4. Steel recessing flanges for recessing fan-coil units into wall.
- F. Casing Insulation: 1/2-inch (13-mm) thick, foil-covered, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916. Maximum thermal conductivity shall be .24 (BTU • in) / (hr • ft<sup>2</sup> • deg. F)
  1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84, UL 723 and NFPA 90A.
- G. Main Drain Pans: Insulated galvanized steel with plastic liner. Fabricate pans and drain connections to comply with ASHRAE 62.1-2004. Provide a high level switch in the drain pan factory wired back to the unit terminal strip to shut down the fan and a digital alarm to the BAS system.
- H. Condensate Pump Drain Pan: Provide a condensate pump drain pan for condensate overflow from the condensate pump with a condensate detector sensor. Drain pan shall be double wall insulated, galvanized steel. The switch shall be factory wired back to the unit terminal strip to shut down the fan upon overflow detection and a digital alarm to the BAS system.
- I. Chassis: Galvanized steel where exposed to moisture. Floor-mounting units shall have leveling screws.
- J. Mixing Box Section (where shown on drawings): Provide a fully insulated integral mixing box section with return and ventilation air dampers, including the interconnecting damper linkage. Mixing box section shall be shipped attached to the concealed plenum unit as an assembly. Damper actuators shall be provided by fan coil unit manufacturer. Coordinate with contractor.

1. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.
- K. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.
  2. Provide with rear, bottom or side filter removal as required for field coordination/access.
- L. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), rated for a minimum working pressure of 300 psig (1378 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve. All coils shall be ARI 410 certified and tagged with an ARI 410 label.
1. Cooling and heating coils shall be in separate coil casings and have a minimum 2 inch gap between them and 1-1/2 inch of clearance on the entering and leaving air sides to allow access from bottom of unit for cleaning when the drain pan is removed. Common tube sheets and coil casing are not acceptable. Water coils on concealed models shall be field reversible for right, left or opposite side connections.
- M. Sound: Units shall have published sound power level data tested in accordance with ARI Standard 350-2000 (non-ducted equipment), ARI Standard 260-2001 (ducted equipment) and as scheduled on drawings.
- N. Provide condensate pumps as scheduled on drawings and shown on plans.
- O. Fan Assembly:
1. Unit fan shall be a dynamically balanced, forwardly curved, DWDI centrifugal type constructed of 18 gauge zinc coated galvanized steel for corrosion resistance. Motors shall be high efficiency, permanently lubricated sleeve bearing, permanent split-capacitor type with UL and CSA listed automatic reset thermal overload protection and three separate horsepower taps or ECM motors as scheduled on drawings. Single speed motors are not acceptable.
  2. The fan assembly shall be easily removable for servicing the motor and blower at, or away from the unit. The entire fan assembly shall be able to come out of the unit by removing two screws and unplugging the motor. Plenum unit fan assemblies shall be easily serviced through an access panel provided.
  3. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23.
  4. Wiring Termination: Connect motor to chassis wiring with plug connection.
  5. ECM Motors - Motors to be DC and brush-less equal to GE ICM2+. All motors to be complete with and operated by a single phase integrated controller/inverter that operates the wound stator and senses rotor position to electrically commutate the stator. All motors to be designed for synchronous rotation. Motor to be permanent magnet type with near zero rotor losses. Motor to be built in soft start and soft speed change ramps. Motor to be direct coupled lubricated with ball bearings. Sleeve bearings are not acceptable. Motor to be direct coupled to the blower. Motor to maintain minimum efficiency of 70% over its entire operating range. The manufacture of the fan powered boxes to set the fan CFM at the factory. Fan CFM to be constant within  $\pm 5\%$  regardless of the change in static whether upstream or down stream of the terminal unit after it is installed. Fan CFM is to be set with a potentiometer. Provide a variable speed switch to allow field adjustments. Fan CFM to be remotely set at the building DDC system through the dynamic speed control at the ECM motor.
- P. Factory, Hydronic Piping Package: ASTM B 88, Type L copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet.
1. Two-way or three-way, modulating control valve for chilled-water coil. Refer to drawings.

2. Two-way or three-way, modulating control valve for heating coil. Refer to drawings.
3. Two-Piece Ball Valves: Bronze body with full-port, chrome-plated bronze ball; PTFE or TFE seats; and 600-psig (4140-kPa) minimum CWP rating and blowout-proof stem.
4. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig (860-kPa) working pressure, 250-deg F (121-deg C) maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.
5. Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig (2070-kPa) working pressure at 250 deg F (121 deg C), with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig (13.8 to 552 kPa).
6. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig (860-kPa) working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 (DN 15) hose-end, full-port, ball-type blowdown valve in drain connection.
7. Wrought-Copper Unions: ASME B16.22.
8. Risers: ASTM B 88, Type L copper pipe with hose and ball valve for system flushing.

Q. Electrical Connection: Factory wire motors and controls for a single point electrical connection.

R. Control devices and operational sequences are specified in Division 23, Instrumentation and Control for HVAC, Sequence of Operations for HVAC Controls, and control sequences on drawings. Provide integral thermostats and controls for vertical wall recessed and horizontal (exposed) cabinet units.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install fan-coil units level and plumb.
- B. Install fan-coil units to comply with NFPA 90A.
- C. Suspend fan-coil units from structure with specified vibration isolation. Vibration isolators are specified in Division 23, Vibration Controls for HVAC Piping and Equipment.
- D. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

### **3.3 CONNECTIONS**

- A. Piping installation requirements are specified in other Division 23. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
  1. Install piping adjacent to machine to allow service and maintenance.

2. Connect condensate drain to indirect waste.
    - a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.
  3. Install both the primary drain pan high level switch and condensate drain pan condensate detector switch wired back to fan coil unit terminal strip to shut down unit and alarm BAS upon detection.
- B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23, Air Duct Accessories. Comply with safety requirements in UL 1995 for duct connections.
  - C. Ground equipment according to Division 26, Grounding and Bonding for Electrical Systems.
  - D. Connect wiring according to Division 26, Low-Voltage Electrical Power Conductors and Cables.

### **3.4 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. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.

### **3.5 ADJUSTING**

- A. Adjust initial temperature and humidity set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

### **3.6 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Division 01, Demonstration and Training.

**END OF SECTION 23 82 19**

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## **SECTION 23 09 00 - INSTRUMENTATION AND CONTROL FOR HVAC**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. This Section includes provision of control sequences for HVAC systems, subsystems, and equipment indicated on the drawings and other Division 23 specification sections.
- C. Where other Division 23 Sections include a requirement for manufacturer equipment controllers (e.g. chillers, boilers, packaged units that are specified with packaged controls), this Section shall be responsible for provision of control components and software required to perform sequences of operation outlined that are in addition to the capabilities of the controllers provided with the manufacturer equipment. Coordinate and integrate all equipment controllers.

#### **1.3 DEFINITIONS**

- A. DDC: Direct digital control.
- B. I/O: Input/output.
- C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
- D. MS/TP: Master slave/token passing.
- E. PC: Personal computer.
- F. PID: Proportional plus integral plus derivative.
- G. RTD: Resistance temperature detector.

#### **1.4 SYSTEM PERFORMANCE**

- A. Comply with the following performance requirements:
  - 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.

2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
  - a. Water Temperature: Plus or minus 1 deg F (0.5 deg C).
  - b. Water Flow: Plus or minus 5 percent of full scale.
  - c. Water Pressure: Plus or minus 2 percent of full scale.
  - d. Space Temperature: Plus or minus 1 deg F (0.5 deg C).
  - e. Ducted Air Temperature: Plus or minus 1 deg F (0.5 deg C).
  - f. Outside Air Temperature: Plus or minus 2 deg F (1.0 deg C).
  - g. Dew Point Temperature: Plus or minus 3 deg F (1.5 deg C).
  - h. Temperature Differential: Plus or minus 0.25 deg F (0.15 deg C).
  - i. Relative Humidity: Plus or minus 5 percent.
  - j. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
  - k. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
  - l. Airflow (Terminal): Plus or minus 10 percent of full scale.
  - m. Air Pressure (Space): Plus or minus 0.01-inch wg (2.5 Pa).
  - n. Air Pressure (Ducts): Plus or minus 0.1-inch wg (25 Pa).
  - o. Carbon Monoxide: Plus or minus 5 percent of reading.
  - p. Carbon Dioxide: Plus or minus 50 ppm.
  - q. Electrical: Plus or minus 5 percent of reading.

## 1.5 SEQUENCE OF OPERATION

- A. Provide control components and software required to perform sequences of operation indicated on the drawings and other Division 23 specification sections. Coordinate and integrate equipment manufacturer controllers. Provide control components in addition to equipment controllers to perform sequences outlined.

## 1.6 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
  1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
  2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
  3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- 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. Bill of materials of equipment indicating quantity, manufacturer, and model number.
  2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
  3. Wiring Diagrams: Power, signal, and control wiring.
  4. Details of control panel faces, including controls, instruments, and labeling.
  5. Written description of sequence of operation.
  6. Schedule of dampers including size, leakage, and flow characteristics.
  7. Schedule of valves including flow characteristics.
  8. DDC System Hardware:
    - a. Wiring diagrams for control units with termination numbers.
    - b. Schematic diagrams and floor plans for field sensors and control hardware.
    - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
  9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
  10. Controlled Systems:
    - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    - c. Written description of sequence of operation including schematic diagram.
    - d. Points list.
- C. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.
- D. Samples for Verification: For each color required, of each type of thermostat or sensor cover.

## 1.7 INFORMATIONAL SUBMITTALS

- A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- B. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with LonWorks.
- C. Qualification Data: For Installer and manufacturer.
- D. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- E. Field quality-control test reports.

## 1.8 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, Operation and Maintenance Data, include the following:
  1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
  2. Interconnection wiring diagrams with identified and numbered system components and devices.
  3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
  4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
  5. Calibration records and list of set points.

- B. Software and Firmware Operational Documentation: Include the following:
  - 1. Software operating and upgrade manuals.
  - 2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
  - 3. Device address list.
  - 4. Printout of software application and graphic screens.
  - 5. Software license required by and installed for DDC workstations and control systems.

## **1.9 MAINTENANCE MATERIAL SUBMITTALS**

- 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. Replacement Materials: One replacement diaphragm or relay mechanism for each unique valve motor, controller, thermostat, or positioning relay.
  - 2. Maintenance Materials: Two thermostat adjusting key(s).

## **1.10 QUALITY ASSURANCE**

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- 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 ASHRAE 135 for DDC system components.

## **1.11 DELIVERY, STORAGE, AND HANDLING**

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

## **1.12 COORDINATION**

- A. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.
- B. Coordinate equipment with Division 28, Intrusion Detection to achieve compatibility with equipment that interfaces with that system and with building master clock.
- C. Coordinate equipment with Division 28, Access Control to achieve compatibility with equipment that interfaces with that system.
- D. Coordinate equipment with Division 27, Clock Systems to achieve compatibility with equipment that interfaces with that system.
- E. Coordinate equipment with Division 28, PLC Electronic Detention Monitoring and Control Systems to achieve compatibility with equipment that interfaces with that system.
- F. Coordinate equipment with Division 26, Addressable-Fixture Lighting Controls and Division 26, Relay-Based Lighting Controls to achieve compatibility with equipment that interfaces with that system.

- G. Coordinate equipment with Division 28, Digital, Addressable Fire-Alarm System and Division 28, Zoned (DC Loop) Fire-Alarm System to achieve compatibility with equipment that interfaces with that system.
- H. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.
- I. Coordinate equipment with Division 26, Electrical Power Monitoring and Control to achieve compatibility of communication interfaces.
- J. Coordinate equipment with Division 26, Panelboards to achieve compatibility with starter coils and annunciation devices.
- K. Coordinate equipment with Division 26, Motor-Control Centers to achieve compatibility with motor starters and annunciation devices.
- L. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03, Cast-in-Place Concrete.

## **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. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

### **2.2 CONTROL SYSTEM**

- A. Manufacturers shall be the following or approved equivalent:
  1. Johnson Controls, Inc.; Contact:  
Yao Dong (727-239-1135)  
Johnson Controls Factory Branch  
264 Fernwood Ave.  
Edison NJ, 08837
- B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.
- C. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.
- D. Control system shall include the following:
  1. Building intrusion detection system specified in Division 28, Intrusion Detection.
  2. Building clock control system specified in Division 27, Clock Systems.
  3. Building lighting control system specified in Division 26 Addressable-Fixture Lighting Controls and Division 26, Relay-Based Lighting Controls.

4. Fire alarm system specified in Division 28, Digital, Addressable Fire-Alarm System and Division 28, Zoned (DC Loop) Fire-Alarm System.

## 2.3 DDC EQUIPMENT

- A. Operator Workstation: One PC-based microcomputer(s) with minimum configuration as follows:
  1. Motherboard: With 8 integrated USB 2.0 ports, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring
  2. Processor: Pentium 4 processor. 2.8 GHz Clock Speed (2.0 GHz minimum)
  3. Random-Access Memory: 1 GB (512 MB Minimum)
  4. Monitor: 17 inches (430 mm)(480 mm), LCD color.
  5. Keyboard: QWERTY, 105 keys in ergonomic shape.
  6. Floppy-Disk Drive: 1.44 MB.
  7. Hard-Disk Drive: 80 GB free hard drive space (40GB minimum)
  8. CD-ROM Read/Write Drive: 32X performance
  9. Mouse: Three button, optical.
  10. Uninterruptible Power Supply: 2 kVa.
  11. Operating System: Windows XP Professional or Windows 7 (64 bit)
    - a. ASHRAE 135 Compliance: Workstation shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
    - b. Where user interface is not provided via browser, provide complete operator workstation software package, including any hardware or software keys. Include the original installation disks and licenses for all included software, device drivers, and peripherals.
    - c. Provide software registration cards to the Owner for all included software.
  12. Printer: Hewlett Packard DeskJet
    - a. Print Speed: 600 DPI Black, 300 DPI Color
    - b. Buffer – 64 K input print buffer
    - c. Color printing: include color kit
  13. Application Software:
    - a. I/O capability from operator station.
    - b. System security for each operator via software password and access levels.
    - c. Automatic system diagnostics; monitor system and report failures.
    - d. Database creation and support.
    - e. Automatic and manual database save and restore.
    - f. Dynamic color graphic displays with up to 10 screen displays at once.
    - g. Custom graphics generation and graphics library of HVAC equipment and symbols.
    - h. Alarm processing, messages, and reactions.
    - i. Trend logs retrievable in spreadsheets and database programs.
    - j. Alarm and event processing.
    - k. Object and property status and control.
    - l. Automatic restart of field equipment on restoration of power.
    - m. Data collection, reports, and logs. Include standard reports for the following:
      - 1) Current values of all objects.
      - 2) Current alarm summary.
      - 3) Disabled objects.
      - 4) Alarm lockout objects.
      - 5) Logs.
    - n. Custom report development.
    - o. Utility and weather reports.
    - p. Workstation application editors for controllers and schedules.
    - q. Maintenance management.
  14. Custom Application Software:
    - a. English language oriented.
    - b. Full-screen character editor/programming environment.
    - c. Allow development of independently executing program modules with debugging/simulation capability.

- d. Support conditional statements.
  - e. Support floating-point arithmetic with mathematic functions.
  - f. Contains predefined time variables.
- B. Diagnostic Terminal Unit: Portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network with minimum configuration as follows:
- 1. System: With one integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.
  - 2. Processor: Pentium 4 processor. 2.8 GHz Clock Speed (2.0 GHz minimum)
  - 3. Random-Access Memory: 1 GB (512 MB Minimum)
  - 4. Monitor: 17 inches (430 mm) Keyboard: QWERTY 105 keys in ergonomic shape.
  - 6. Floppy-Disk Drive: 1.44 MB.
  - 7. Hard-Disk Drive: 40 GB free hard drive space
  - 8. CD-ROM Read/Write Drive: 32X performance
  - 9. Pointing Device: Touch pad or other internal device.
- C. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
- 1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.
  - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
    - a. Global communications.
    - b. Discrete/digital, analog, and pulse I/O.
    - c. Monitoring, controlling, or addressing data points.
    - d. Software applications, scheduling, and alarm processing.
    - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
  - 3. Standard Application Programs:
    - a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
    - b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.
    - c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.
    - d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
    - e. Remote communications.
    - f. Maintenance management.
    - g. Units of Measure: Inch-pound and SI (metric).
  - 4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
  - 5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
  - 6. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.
- D. Local Control Units: Modular, comprising processor board with electronically programmable, non-volatile, read-only memory; and backup power source.
- 1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.
  - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
    - a. Global communications.

- b. Discrete/digital, analog, and pulse I/O.
    - c. Monitoring, controlling, or addressing data points.
  - 3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
  - 4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
  - 5. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.
- E. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
- 1. Binary Inputs: Allow monitoring of on-off signals without external power.
  - 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
  - 3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
  - 4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.
  - 5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.
  - 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
  - 7. Universal I/Os: Provide software selectable binary or analog outputs.
- F. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
- 1. Output ripple of 5.0 mV maximum peak to peak.
  - 2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
  - 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- G. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
- 1. Minimum dielectric strength of 1000 V.
  - 2. Maximum response time of 10 nanoseconds.
  - 3. Minimum transverse-mode noise attenuation of 65 dB.
  - 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.
- H. All NAE and FEC panels shall be connected to stand-by power. ATC contractor shall provide panel mount UPS power supplies. Power supplies shall be capable of providing full power to the ATC system for 15 minutes.

## 2.4 UNITARY CONTROLLERS

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
- 1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
  - 2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform automatic system diagnostics; monitor system and report failures.
  - 3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using



- MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
4. LonWorks Compliance: Communicate using EIA/CEA 709.1 datalink/physical layer protocol using LonTalk protocol.
  5. Enclosure: Dustproof rated for operation at 32 to 120 deg F (0 to 50 deg C).
  6. Enclosure: Waterproof rated for operation at 40 to 150 deg F (5 to 65 deg C).

## **2.5 ALARM PANELS**

- A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch- (1.5-mm-) thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish.
- B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.
  1. Alarm Condition: Indicating light flashes and horn sounds.
  2. Acknowledge Switch: Horn is silent and indicating light is steady.
  3. Second Alarm: Horn sounds and indicating light is steady.
  4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
  5. Contacts in alarm panel allow remote monitoring by independent alarm company.

## **2.6 ANALOG CONTROLLERS**

- A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.
- B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F (minus 23 to plus 21 deg C), and single- or double-pole contacts.
- C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.
  1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.
- D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.
- E. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
  1. Remote-control-point adjustment shall be plus or minus 20 percent of sensor span, input signal of 3 to 13 psig (21 to 90 kPa).
  2. Proportional band shall extend from 2 to 20 percent for 5 psig (35 kPa).
  3. Authority shall be 20 to 200 percent.
  4. Air-supply pressure of 18 psig (124 kPa), input signal of 3 to 15 psig (21 to 103 kPa), and output signal of zero to supply pressure.
  5. Gages: 2-1/2 inches (64 mm) in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

## 2.7 TIME CLOCKS

- A. Available Manufacturers or approved equivalent:
  - 1. ATC-Diversified Electronics.
  - 2. Grasslin Controls Corporation.
  - 3. Paragon Electric Co., Inc.
  - 4. Precision Multiple Controls, Inc.
  - 5. SSAC Inc.; ABB USA.
  - 6. TCS/Basys Controls.
  - 7. Theben AG - Lumilite Control Technology, Inc.
  - 8. Time Mark Corporation.
  
- B. Seven-day, programming-switch timer with synchronous-timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.
  
- C. Solid-state, programmable time control with 8 separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

## 2.8 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
  
- B. Thermistor Temperature Sensors and Transmitters:
  - 1. Available Manufacturers or approved equivalent:
    - a. Johnson Controls JCI
    - b. BEC Controls Corporation.
    - c. Ebtron, Inc.
    - d. Heat-Timer Corporation.
    - e. I.T.M. Instruments Inc.
    - f. MAMAC Systems, Inc.
    - g. RDF Corporation.
  - 2. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.
  - 3. Wire: Twisted, shielded-pair cable.
  - 4. Insertion Elements in Ducts: Single point, 18 inches (460 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
  - 5. Averaging Elements in Ducts: 36 inches (915 mm) long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
  - 6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
  - 7. Room Sensor Cover Construction: Manufacturer's standard covers.
    - a. Set-Point Adjustment: Exposed (in office areas), Concealed (in library areas)
    - b. Set-Point Indication: Exposed (in office areas), Concealed (in library areas)
    - c. Thermometer: Concealed.
    - d. Orientation: Vertical, wall mounted.
  - 8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
  
- C. RTDs and Transmitters:
  - 1. Available Manufacturers or approved equivalent:
    - a. Johnson Controls JCI
    - b. BEC Controls Corporation.
    - c. MAMAC Systems, Inc.
    - d. RDF Corporation.

2. Accuracy: Plus or minus 0.2 percent at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 18 inches (460 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
5. Averaging Elements in Ducts: 48 inches (1200 mm) long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.
6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
  - a. Set-Point Adjustment: Exposed (in office areas), Concealed (in library areas)
  - b. Set-Point Indication: Exposed (in office areas), Concealed (in library areas)
  - c. Thermometer: Concealed.
  - d. Orientation: Vertical, wall mounted.
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

D. Humidity Sensors: Bulk polymer sensor element.

1. Available Manufacturers or approved equivalent:
  - a. Johnson Controls JCI
  - b. BEC Controls Corporation.
  - c. General Eastern Instruments.
  - d. MAMAC Systems, Inc.
  - e. ROTRONIC Instrument Corp.
  - f. TCS/Basys Controls.
  - g. Vaisala.
2. Accuracy: 5 percent full range with linear output.
3. Room Sensor Range: 20 to 80 percent relative humidity.
4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
  - a. Set-Point Adjustment: Concealed.
  - b. Set-Point Indication: Concealed.
  - c. Thermometer: Concealed.
  - d. Orientation: Vertical.
5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 0 to 120 deg F.
7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Pressure Transmitters/Transducers:

1. Available Manufacturers or approved equivalent:
  - a. Johnson Controls JCI
  - b. BEC Controls Corporation.
  - c. General Eastern Instruments.
  - d. MAMAC Systems, Inc.
  - e. ROTRONIC Instrument Corp.
  - f. TCS/Basys Controls.
  - g. Vaisala.
2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
  - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
  - b. Output: 4 to 20 mA.
  - c. Building Static-Pressure Range: 0- to 0.25-inch wg (0 to 62 Pa).
  - d. Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa).
3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure; linear output 4 to 20 mA.

4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure and tested to 300-psig (2070-kPa); linear output 4 to 20 mA.
  5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
  6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.
- F. Room Sensor Cover Construction: Manufacturer's standard locking covers.
1. Set-Point Adjustment: Concealed.
  2. Set-Point Indication: Concealed.
  3. Thermometer: Concealed.
  4. Orientation: Vertical.
- G. Room sensor accessories include the following:
1. Insulating Bases: For sensors located on exterior walls.

## 2.9 STATUS SENSORS

- A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).
- B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.
- C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.
1. Available Manufacturers or approved equivalent:
    - a. BEC Controls Corporation.
    - b. I.T.M. Instruments Inc.

## 2.10 GAS DETECTION EQUIPMENT

- A. Available Manufacturers or approved equivalent:
1. Johnson Controls JCI
  2. B. W. Technologies.
  3. CEA Instruments, Inc.
  4. Ebtron, Inc.

5. Gems Sensors Inc.
  6. Greystone Energy Systems Inc.
  7. Honeywell International Inc.; Home & Building Control.
  8. INTEC Controls, Inc.
  9. I.T.M. Instruments Inc.
  10. MSA Canada Inc.
  11. QEL/Quatrosense Environmental Limited.
  12. Sauter Controls Corporation.
  13. Sensidyne, Inc.
  14. TSI Incorporated.
  15. Vaisala.
  16. Vulcain Inc.
- B. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F (0 to 40 deg C); with 2 factory-calibrated alarm levels at 50 and 100 ppm.
- C. Combination temperature and carbon dioxide transmitter:
1. Available Manufacturers or approved equivalent:
    - a. Johnson Controls JCI - model: "CD-W00-x0-2"
  2. CO2 range levels from 0-2,000 parts per million  $\pm$ (30ppm +3% of reading)
  3. Long-Term Stability  $\pm$ (15 ppm +2% of reading) over 5 years.
  4. Temperatures Ranging from 32-122°F  $\pm$ 0.34°F accuracy.
  5. 0-10V & 4-20mA signals.
  6. Platinum temperature sensor PT1000 RTD.
- D. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55 deg C) and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.
- E. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; suitable over a temperature range of minus 32 to plus 1100 deg F (0 to 593 deg C) and calibrated for 0 to 5 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.
- F. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

## 2.11 FLOW MEASURING STATIONS

- A. Duct Airflow Station: Air flow/temperature measuring station.
1. Available Manufacturers or approved equivalent:
    - a. Tamco/Ebtron - model#: GTX116-P+
  2. Casing: Extruded-aluminum frame.
  3. Sensing Manifold: Anodized aluminum tube manifold with hermetically sealed bead-in-glass waterproof thermistors. Chip thermistors of any type are not acceptable.
  4. BACNET capable.
  5. Transmitter to be microprocessor based and powered by a 24VAC/DC
  6.  $\pm$ 2% accuracy
  7. Calibrated from 0-5,000 fpm.
- B. Air Handling Unit Fan Array Airflow Stations: Air flow measuring station.
1. THERMOS Available Manufacturers or approved equivalent:
    - a. Tamco/Ebtron - model#: GTx108-F/An
  2. Sensor Probe Mounting Brackets: 304 stainless steel
  3. Supports up to 8 fans. 1 probe x 1 sensor node per probe in each fan
  4. Sensing Manifold: Anodized aluminum tube manifold with hermetically sealed bead-in-glass waterproof thermistors. Chip thermistors of any type are not acceptable.

5. BACNET capable.
6. Transmitter to be microprocessor based and powered by a 24VAC/DC
7. +2% accuracy
8. Calibrated from 0-10,000 fpm.

## 2.12 THERMOSTATS

- A. Available Manufacturers or approved equivalent:
  1. Johnson Controls JCI
  2. Ernie Controls
  3. Danfoss Inc.; Air-Conditioning and Refrigeration Div.
  4. Heat-Timer Corporation.
  5. Sauter Controls Corporation.
  6. tekmar Control Systems, Inc.
  7. Theben AG - Lumilite Control Technology, Inc.
  
- B. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.
  1. Label switches FAN HIGH-MED-LOW-OFF".
  2. Mount on single electric switch box.
  
- C. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
  1. Automatic switching from heating to cooling.
  2. Preferential rate control to minimize overshoot and deviation from set point.
  3. Set up for four separate temperatures per day.
  4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
  5. Short-cycle protection.
  6. Programming based on every day of week.
  7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
  8. Battery replacement without program loss.
  9. Thermostat display features include the following:
    - a. Time of day.
    - b. Actual room temperature.
    - c. Programmed temperature.
    - d. Programmed time.
    - e. Duration of timed override.
    - f. Day of week.
    - g. System mode indications include "heating," "off," "fan auto," and "fan on."
  
- D. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.
  
- E. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.
  1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
  2. Selector Switch: Integral, manual on-off-auto.
  
- F. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
  1. Bulbs in water lines with separate wells of same material as bulb.
  2. Bulbs in air ducts with flanges and shields.

3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
  4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
  5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
  6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.
- G. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F (24 deg C) above normal maximum operating temperature, and the following:
1. Reset: Manual.
  2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.
- H. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.
- I. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.
- J. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.
1. Bulb Length: Minimum 20 feet (6 m).
  2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.
- K. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic-reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or above set point.
1. Bulb Length: Minimum 20 feet (6 m).
  2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.
- L. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig (172 kPa), and cast housing with position indicator and adjusting knob.

## 2.13 HUMIDISTATS

- A. Manufacturers or approved equal:
1. Johnson Controls JCI
  2. MAMAC Systems, Inc.
  3. ROTRONIC Instrument Corp.
- B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

## 2.14 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
1. Comply with requirements in Division 23, Common Motor Requirements for HVAC Equipment.

2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
  3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
  4. Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
  5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
  6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Available Manufacturers or approved equal:
    - a. Johnson Controls JCI
    - b. Belimo Aircontrols (USA), Inc.
  2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
  3. Dampers: Size for running torque calculated as follows:
    - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
    - b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
    - c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. (49.6 kg-cm/sq. m) of damper.
    - d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
    - e. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
    - f. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
  4. Coupling: V-bolt and V-shaped, toothed cradle.
  5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
  6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
  7. Power Requirements (Two-Position Spring Return): 120-V ac.
  8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
  9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
  10. Temperature Rating: Minus 22 to plus 122 deg F.
  11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.
  12. Run Time: 30 seconds.

## 2.15 CONTROL VALVES

- A. Provide products by one of the following or approved equivalent:
1. Johnson Controls JCI
  2. Danfoss Inc.; Air Conditioning & Refrigeration Div.
  3. Erie Controls.
  4. Hayward Industrial Products, Inc.
  5. Magnatrol Valve Corporation.
  6. Neles-Jamesbury.
  7. Parker Hannifin Corporation; Skinner Valve Division.
  8. Pneuline Controls.
  9. Sauter Controls Corporation.



- B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- C. Hydronic system globe valves shall have the following characteristics:
1. NPS 2 (DN 50) and Smaller: Class 250 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
  2. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
  3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
    - a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
    - b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.
  4. Sizing: 5-psig (35-kPa) maximum pressure drop at design flow rate or the following:
    - a. Two Position: Line size.
    - b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
    - c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
  5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
  6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.
- D. Steam system globe valves shall have the following characteristics:
1. NPS 2 (DN 50) and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.
  2. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
  3. Internal Construction: Replaceable plugs and stainless-steel seats.
    - a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
    - b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
  4. Sizing: For pressure drop based on the following services:
    - a. Two Position: 20 percent of inlet pressure.
    - b. Modulating 15-psig (103-kPa) Steam: 80 percent of inlet steam pressure.
  5. Flow Characteristics: Modified linear characteristics.
  6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of operating (inlet) pressure.
- E. Butterfly Valves: 200-psig (1380-kPa), 150-psig (1034-kPa) maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
1. Body Style: Lug.
  2. Disc Type: Aluminum bronze.
  3. Sizing: 1-psig (7-kPa) maximum pressure drop at design flow rate.
- F. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
1. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
  2. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head.
  3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

- G. Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
  - 1. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
  - 2. Thermostatic Operator: Liquid-filled integral sensor with integral adjustable dial.

## 2.16 DAMPERS

- A. Available Manufacturers or approved equivalent:
  - 1. Air Balance Inc.
  - 2. Don Park Inc.; Autodamp Div.
  - 3. TAMCO (T. A. Morrison & Co. Inc.).
  - 4. United Enertech Corp.
  - 5. Vent Products Company, Inc.
  
- B. Dampers: AMCA-rated, parallel blade for isolation dampers and opposed-blade design for modulating dampers; 0.108-inch- (2.8-mm-) minimum thick, galvanized-steel or 0.125-inch- (3.2-mm-) minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- (1.6-mm-) thick galvanized steel with maximum blade width of 8 inches (200 mm) and length of 48 inches (1220 mm).
  - 1. Secure blades to 1/2-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
  - 2. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
  - 3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
  - 4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that power supply is available to control units and operator workstation.

### 3.2 INSTALLATION

- A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm) above the floor.
  - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- D. Install guards on thermostats in the following locations:
  - 1. Entrances.
  - 2. Public areas.
  - 3. Where indicated.

- E. Install automatic dampers according to Division 23 for Air Duct Accessories.
- F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- G. Install labels and nameplates to identify control components according to Division 23, Identification for HVAC Piping and Equipment.
- H. Install hydronic instrument wells, valves, and other accessories according to Division 23, Hydronic Piping.
- I. Install steam and condensate instrument wells, valves, and other accessories according to Division 23, Steam and Condensate Heating Piping.
- J. Install refrigerant instrument wells, valves, and other accessories according to Division 23, Refrigerant Piping.
- K. Install duct volume-control dampers according to Division 23, Metal Ducts and Division 23, Non-metal Ducts.
- L. Install electronic and fiber-optic cables according to Division 27, Communications Horizontal Cabling.

### **3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION**

- A. Install raceways, boxes, and cabinets according to Division 26, Raceways and Boxes for Electrical Systems.
- B. Install building wire and cable according to Division 26, Low-Voltage Electrical Power Conductors and Cables.
- C. Install signal and communication cable according to Division 27, Communications Horizontal Cabling.
  - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
  - 2. Install exposed cable in raceway.
  - 3. Install concealed cable in raceway.
  - 4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
  - 5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
  - 6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
  - 7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

### 3.4 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. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
  2. Test and adjust controls and safeties.
  3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  4. Pressure test control air piping at 30 psig (207 kPa) or 1.5 times the operating pressure for 24 hours, with maximum 5-psig (35-kPa) loss.
  5. Pressure test high-pressure control air piping at 150 psig (1034 kPa) and low-pressure control air piping at 30 psig (207 kPa) for 2 hours, with maximum 1-psig (7-kPa) loss.
  6. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
  7. Test each point through its full operating range to verify that safety and operating control set points are as required.
  8. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
  9. Test each system for compliance with sequence of operation.
  10. Test software and hardware interlocks.
- C. DDC Verification:
1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
  2. Check instruments for proper location and accessibility.
  3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
  4. Check instrument tubing for proper fittings, slope, material, and support.
  5. Check installation of air supply for each instrument.
  6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
  7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
  8. Check temperature instruments and material and length of sensing elements.
  9. Check control valves. Verify that they are in correct direction.
  10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
  11. Check DDC system as follows:
    - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    - c. Verify that spare I/O capacity has been provided.
    - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

### 3.5 ADJUSTING

- A. Calibrating and Adjusting:
1. Calibrate instruments.
  2. Make three-point calibration test for both linearity and accuracy for each analog instrument.

3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
  4. Control System Inputs and Outputs:
    - a. Check analog inputs at 0, 50, and 100 percent of span.
    - b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    - c. Check digital inputs using jumper wire.
    - d. Check digital outputs using ohmmeter to test for contact making or breaking.
    - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
  5. Flow:
    - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    - b. Manually operate flow switches to verify that they make or break contact.
  6. Pressure:
    - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
  7. Temperature:
    - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    - b. Calibrate temperature switches to make or break contacts.
  8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
  9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
  10. Provide diagnostic and test instruments for calibration and adjustment of system.
  11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature and humidity set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

### **3.6 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01, Demonstration and Training.

**END OF SECTION**

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## SECTION 23 21 13.13 - UNDERGROUND HYDRONIC PIPING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Conduit piping system.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:
  - 1. Chilled-Water Piping: [150 psig] at [200 deg F].
  - 2. ACTION SUBMITTALS
- B. Product Data: For the following:
  - 1. Conduit piping.
  - 2. Product Data for Credit EQ 4.1: For adhesives, documentation including printed statement of VOC content and chemical components.
- C. Shop Drawings: For underground hydronic piping. Signed and sealed by a professional engineer.
  - 1. Calculate requirements for expansion compensation for underground piping.
  - 2. Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement in the required locations. Show anchors and guides that restrain piping movement with calculated loads, and show concrete thrust block dimensions.
  - 3. Show pipe sizes, locations, and elevations. Show piping in trench, conduit, and cased pipe with details showing clearances between piping, and show insulation thickness.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1 inch equals 50 feet and at vertical scale of not less than 1 inch equals 5 feet. Indicate manholes and piping. Show types, sizes, materials, and elevations of other utilities crossing hydronic piping.
- B. Qualification Data: For qualified Installer.
- C. Welding certificates.
- D. Material Test Reports: For [conduit] piping.
- E. Source quality-control reports.

- F. Field quality-control reports.

## 1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX.
  - 1. Comply with provisions in ASME B31.9, "Building Services Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

## PART 2 - PRODUCTS

### 2.1 STEEL PIPES AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, [black] with plain ends; type, grade, and wall thickness as indicated in "Piping Application" Article.
- B. Steel Welding Fittings: [ASME B16.9], seamless or welded.
  - 1. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

### 2.2 CONDUIT PIPING SYSTEM

- A. Description: Factory-fabricated and -assembled, airtight and watertight, drainable, pressure-tested piping with conduit, inner pipe supports, and insulated carrier piping. Fabricate so insulation can be dried in place by forcing dry air through conduit.
  - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. Insul-Tek Piping Systems, Inc.
    - b. Perma-Pipe, Inc.
    - c. Rovanco Piping Systems, Inc.
    - d. Thermacor Process, L.P.
- B. Carrier Pipe: [Schedule 80, steel pipe and fittings].
- C. Carrier Pipe Insulation:
  - 1. Polyurethane Foam Pipe Insulation: Unfaced, preformed, rigid cellular polyurethane material intended for use as thermal insulation.
    - a. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.
    - b. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches as tested by ASTM E 84.
    - c. Fabricate shapes according to ASTM C 450 and ASTM C 585.
- D. Minimum Clearance:
  - 1. Between Carrier Pipe Insulation and Conduit: 1 inch.

2. Between Insulation of Multiple Carrier Pipes: 3/16 inch.
  3. Between Bottom of Carrier Pipe Insulation and Conduit: 1 inch.
  4. Between Bottom of Bare, Carrier Pipe and Casing: 1-3/8 inches.
- E. Conduit: Spiral wound, steel.
1. Finish: With two coats of fusion-bonded epoxy, minimum 20 mils thick.
  2. Cover: With polyurethane foam insulation with an HDPE jacket; thickness indicated in "Piping Application" Article.
  3. Piping Supports within Conduit: Corrugated galvanized steel with a maximum spacing of 10 feet.
  4. Fittings: Factory-fabricated and -insulated elbows and tees. Elbows may be bent pipe equal to carrier pipe. Tees shall be factory fabricated and insulated, and shall be compatible with the carrier pipe.
  5. Expansion Offsets and Loops: Size casing to contain piping expansion.
  6. Accessories include the following:
    - a. Water Shed: Terminal end protector for carrier pipes entering building through floor, 3 inches deep and 2 inches larger than casing; terminate casing 20 inches above the floor level.
    - b. Guides and Anchors: Steel plate welded to carrier pipes and to casing, complete with vent and drainage openings inside casing.
    - c. End Seals: Steel plate welded to carrier pipes and to casing, complete with drain and vent openings on vertical centerline.
    - d. Gland Seals: Packed stuffing box and gland follower mounted on steel plate, welded to end of casing, permitting axial movement of carrier piping, with drain and vent connections on vertical centerline.
    - e. Joint Kit: Half-shell, pourable or split insulation and shrink-wrap sleeve.

### **PART 3 - EXECUTION**

#### **3.1 EARTHWORK**

- A. See Division 31, Earth Moving for excavating, trenching, and backfilling.

#### **3.2 PIPING APPLICATION**

- A. Chilled-Water Piping:

1. **[NPS 2-1/2 and larger]** shall be the following:
  - a. **[Schedule 80]** steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.
2. Conduit piping with **[polyurethane]** carrier-pipe insulation and with **[coated and insulated]** conduit.
  - a. Piping Insulation Thickness: **[1 inch] [2 inches]**.
  - b. Conduit Insulation Thickness: **[1 inch] [2 inches]**.



### **3.3 PIPING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Remove standing water in the bottom of trench.
- C. Do not backfill piping trench until field quality-control testing has been completed and results approved.
- D. Install piping at uniform grade of 0.2 percent. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points and elsewhere as required for system drainage. Install manual air vents at high points.
- E. In conduits, install drain valves at low points and manual air vents at high points.
- F. Install components with pressure rating equal to or greater than system operating pressure.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. See Division 23, Sleeves and Sleeve Seals for HVAC Piping for sleeves and mechanical sleeve seals through exterior building walls.
- J. Secure anchors with concrete thrust blocks. Concrete is specified in Division 03, Cast-in-Place Concrete.
- K. See Division 26, Cathodic Protection for cathodic devices and connections to piping and conduit systems.

### **3.4 JOINT CONSTRUCTION**

- A. See Division 33, Common Work Results for Utilities for basic piping joint construction.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

### **3.5 IDENTIFICATION**

- A. Install continuous plastic underground warning tapes during back filling of trenches for underground hydronic piping. Locate tapes 6 to 8 inches below finished grade, directly over piping. See Division 31, Earth Moving for warning-tape materials and devices and their installation.

### **3.6 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
  - 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. Prepare hydronic piping for testing according to ASME B31.9 and as follows:
    - a. Leave joints, including welds, uninsulated and exposed for examination during test.
    - b. Fill system with water. Where there is risk of freezing, air or a safe, compatible liquid may be used.
    - c. Use vents installed at high points to release trapped air while filling system.
  2. Test hydronic piping as follows:
    - a. Subject hydronic piping to hydrostatic test pressure that is not less than 1.5 times the design pressure.
    - b. After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.
  3. Test conduit as follows:
    - a. Seal vents and drains and subject conduit to 15 psig for four hours with no loss of pressure. Repair leaks and retest as required.
- E. Prepare test and inspection reports.

**END OF SECTION**

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## **SECTION 23 21 13 - HYDRONIC PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes pipe and fitting materials and joining methods for the following:
  - 1. Hot-water heating piping.
  - 2. Glycol cooling water piping.
  - 3. Makeup-water piping.
  - 4. Condensate-drain piping.
  - 5. Air-vent piping.
  - 6. Safety-valve-inlet and -outlet piping.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of the following:
  - 1. Plastic pipe and fittings with solvent cement.
  - 2. RTRP and RTRF with adhesive.
  - 3. Pressure-seal fittings.
  - 4. Chemical treatment.
- B. Delegated-Design Submittal:
  - 1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
  - 2. Locations of pipe anchors and alignment guides and expansion joints and loops.
  - 3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
  - 4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Suspended ceiling components.
  - 2. Other building services.
  - 3. Structural members.
- B. Qualification Data: For Installer.

- C. Welding certificates.
- D. Field quality-control reports.
- E. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

## **1.5 QUALITY ASSURANCE**

- A. Installer Qualifications:
  - 1. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.
- B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
  - 1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
  - 1. Hot-Water Heating Piping: 150 psig at 200 deg F (93 deg C).
  - 2. Glycol Cooling-Water Piping: 150 psig at 200 deg F (93 deg C).
  - 3. Makeup-Water Piping: 80 psig (552 kPa) at 150 deg F (66 deg C).
  - 4. Condensate-Drain Piping: 150 deg F (66 deg C).
  - 5. Air-Vent Piping: 200 deg F (93 deg C).
  - 6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

### **2.2 COPPER TUBE AND FITTINGS**

- A. Annealed-Temper Copper Tubing: ASTM B 88, Type K (ASTM B 88M, Type A).
- B. Wrought-Copper Unions: ASME B16.22.

### **2.3 STEEL PIPE AND FITTINGS**

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.

- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
  - 1. Material Group: 1.1.
  - 2. End Connections: Butt welding.
  - 3. Facings: Raised face.

## 2.4 PLASTIC PIPE AND FITTINGS

- A. CPVC Plastic Pipe: ASTM F 441/F 441M, with wall thickness as indicated in "Piping Applications" Article.
  - 1. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.

## 2.5 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless otherwise indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- F. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Solvent Cements for Joining Plastic Piping:

1. CPVC Piping: ASTM F 493.
  - a. CPVC solvent cement shall have a VOC content of 490 g/L or less.
  - b. Adhesive primer shall have a VOC content of 550 g/L or less.
  - c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

## 2.6 TRANSITION FITTINGS

### A. Plastic-to-Metal Transition Fittings:

1. Products: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - a. Charlotte Pipe and Foundry Company.
  - b. IPEX Inc.
  - c. KBI (King Bros. Industries).
2. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.

## 2.7 DIELECTRIC FITTINGS

### A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

### B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - a. A.Y. McDonald Mfg. Co.
  - b. Capitol Manufacturing Company.
  - c. Central Plastics Company.
  - d. Hart Industries International, Inc.
  - e. Jomar International, Ltd.
  - f. Matco-Norca.
  - g. Watts Regulator Co.
  - h. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.
2. Description:
  - a. Standard: ASSE 1079.
  - b. Pressure Rating: 150 psig (1035 kPa).
  - c. End Connections: Solder-joint copper alloy and threaded ferrous.

### C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - a. Capitol Manufacturing Company.
  - b. Central Plastics Company.
  - c. Matco-Norca.

- d. Watts Regulator Co.
  - e. Zurn Industries, LLC; AquaSpec Commercial Faucet Products.
2. Description:
- a. Standard: ASSE 1079.
  - b. Factory-fabricated, bolted, companion-flange assembly.
  - c. Pressure Rating: 150 psig (1035 kPa).
  - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- D. Dielectric-Flange Insulating Kits:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
- a. Advance Products & Systems, Inc.
  - b. Calpico, Inc.
  - c. Central Plastics Company.
  - d. Pipeline Seal and Insulator, Inc.
2. Description:
- a. Nonconducting materials for field assembly of companion flanges.
  - b. Pressure Rating: 150 psig (1035 kPa).
  - c. Gasket: Neoprene or phenolic.
  - d. Bolt Sleeves: Phenolic or polyethylene.
  - e. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
- a. Elster Perfection.
  - b. Grinnell Mechanical Products.
  - c. Matco-Norca.
  - d. Precision Plumbing Products, Inc.
2. Description:
- a. Standard: IAPMO PS 66.
  - b. Electroplated steel nipple, complying with ASTM F 1545.
  - c. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
  - d. End Connections: Male threaded or grooved.
  - e. Lining: Inert and noncorrosive, propylene.

## **2.8 BYPASS CHEMICAL FEEDER**

- A. Description: Welded steel construction; 125-psig (860-kPa) working pressure; 5-gal. (19-L) capacity; with fill funnel and inlet, outlet, and drain valves.
1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

## **PART 3 - EXECUTION**

### **3.1 PIPING APPLICATIONS**

- A. Hot-water heating piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
  - 1. Type K, seamless hard copper tubing, wrought-copper fittings, and soldered joints (propress acceptable where accessible).
  - 2. Schedule 40, Grade B, ASTM A53/106; Class 150, malleable-iron fittings; and threaded joints.
- B. Hot-water heating piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be the following:
  - 1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints (victaulic joints acceptable where accessible).
- C. Glycol cooling-water piping, aboveground, NPS 2 (DN 50) and smaller, shall be any of the following:
  - 1. Type K, seamless hard copper tubing, wrought-copper fittings, and soldered joints (propress acceptable where accessible).
  - 2. Schedule 40, Grade B, ASTM A53/106; Class 150, malleable-iron fittings; and threaded joints.
- D. Glycol cooling-water piping, aboveground, NPS 2-1/2 (DN 65) and larger, shall be the following:
  - 1. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints (victaulic joints acceptable where accessible).
- E. Makeup-water piping installed aboveground shall be either of the following:
  - 1. Type K, seamless hard copper tubing, wrought-copper fittings, and soldered joints (propress acceptable where accessible).
  - 2. Schedule 40 CPVC plastic pipe and fittings, and solvent-welded joints.
- F. Condensate-Drain Piping: Type K, seamless hard copper tubing, wrought-copper fittings, and soldered joints or Schedule 40 CPVC plastic pipe and fittings and solvent-welded joints.
- G. Air-Vent Piping:
  - 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
  - 2. Outlet: Type K (Type A), annealed-temper copper tubing with soldered or flared joints.
- H. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
- I. See Division 23 for underground hydronic piping.

### **3.2 PIPING INSTALLATIONS**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.



- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to Division 23.
- Q. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.
- S. Install shutoff valve immediately upstream of each dielectric fitting.
- T. Comply with requirements in Division 23 for installation of expansion loops, anchors, and pipe alignment guides.
- U. Comply with requirements in Division 23 for identifying piping.
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23.
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23.

- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23.

### **3.3 DIELECTRIC FITTING INSTALLATION**

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.
- D. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.
- E. Provide isolation valves for dielectric fittings.

### **3.4 HANGERS AND SUPPORTS**

- A. Comply with requirements in Division 23 for hanger, support, and anchor devices. Comply with Division 23 for maximum spacing of supports.
- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
  - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet (6 m) or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
  - 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- C. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- D. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- E. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.

### **3.5 PIPE JOINT CONSTRUCTION**

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

### **3.6 TERMINAL EQUIPMENT CONNECTIONS**

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Division 23.

### **3.7 FIELD QUALITY CONTROL**

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
  - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
  - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
  - 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
  - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
  - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
  2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
  3. Isolate expansion tanks and determine that hydronic system is full of water.
  4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
  5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
  6. Prepare written report of testing.
- C. Perform the following before operating the system:
1. Open manual valves fully.
  2. Inspect pumps for proper rotation.
  3. Set makeup pressure-reducing valves for required system pressure.
  4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
  5. Set temperature controls so all coils are calling for full flow.
  6. Inspect and set operating temperatures of hydronic equipment, such as boilers, and chillers, to specified values.
  7. Verify lubrication of motors and bearings.

**END OF SECTION**

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## **SECTION 23 21 16 - HYDRONIC PIPING SPECIALTIES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes special-duty valves and specialties to service HVAC piping systems as follows:
  - 1. Hydronic Specialty Valves.
  - 2. Air Control Devices.
  - 3. Hydronic Piping Specialties

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of the following:
  - 1. Hydronic specialty valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
  - 2. Air-control devices.
  - 3. Hydronic specialties.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

#### **1.5 MAINTENANCE MATERIAL SUBMITTALS**

#### **1.6 QUALITY ASSURANCE**

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
  - 1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

### **PART 2 - PRODUCTS**

#### **2.1 PERFORMANCE REQUIREMENTS**

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:

1. Hot-Water Heating Piping: <150 psig (1035 kPa)> at [200 deg F].
2. Glycol Cooling-Water Piping: <150 psig (1035 kPa)> at [150 deg F] <Insert temperature>.
3. Makeup-Water Piping: [80 psig (552 kPa)] at [150 deg F].
4. Condensate-Drain Piping: [150 deg F].
5. Blowdown-Drain Piping: [200 deg F].
6. Air-Vent Piping: [200 deg F].
7. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

## 2.2 HYDRONIC SPECIALTY VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23.
- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23.
- C. Brass or Bronze, Calibrated-Orifice, Balancing Valves:
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. Armstrong Pumps, Inc.
    - b. Bell & Gossett Domestic Pump.
    - c. Flow Design Inc.
    - d. Gerand Engineering Co.
    - e. Griswold Controls.
    - f. Macon
    - g. NuTech Hydronic Specialty Products
    - h. Nexus Valve, Inc.
    - i. Taco.
    - j. Tour & Andersson; available through Victaulic Company.
  2. Body: Brass or bronze, ball or plug type with calibrated orifice or venturi.
  3. Ball: Brass or stainless steel.
  4. Plug: Resin.
  5. Seat: PTFE.
  6. End Connections: Threaded or socket.
  7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
  8. Handle Style: Lever, with memory stop to retain set position.
  9. CWP Rating: Minimum 125 psig.
  10. Maximum Operating Temperature: 250 deg F.
- D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:

- a. Armstrong Pumps, Inc.
  - b. Bell & Gossett Domestic Pump.
  - c. Flow Design Inc.
  - d. Gerand Engineering Co.
  - e. Griswold Controls.
  - f. Macon
  - g. NuTech Hydronic Specialty Products
  - h. Nexus Valve, Inc.
  - i. Taco.
  - j. Tour & Andersson.
2. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
  3. Ball: Brass or stainless steel.
  4. Stem Seals: EPDM O-rings.
  5. Disc: Manufacturer standard construction.
  6. Seat: PTFE.
  7. End Connections: Flanged or grooved.
  8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
  9. Handle Style: Lever, with memory stop to retain set position.
  10. CWP Rating: Minimum 125 psig.
  11. Maximum Operating Temperature: 250 deg F.
- E. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. AMTROL, Inc.
    - b. Armstrong Pumps, Inc.
    - c. Bell & Gossett Domestic Pump.
    - d. Conbraco Industries, Inc.
    - e. Spence Engineering Company, Inc.
    - f. Watts Regulator Co.
  2. Body: Bronze or brass.
  3. Disc: Glass and carbon-filled PTFE.
  4. Seat: Brass.
  5. Stem Seals: EPDM O-rings.
  6. Diaphragm: EPT.
  7. Low inlet-pressure check valve.
  8. Inlet Strainer: 304 or 316 stainless steel, removable without system shutdown.
  9. Valve Seat and Stem: Noncorrosive.

10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- F. Diaphragm-Operated Safety Valves: ASME labeled.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. AMTROL, Inc.
    - b. Armstrong Pumps, Inc.
    - c. Bell & Gossett Domestic Pump.
    - d. Conbraco Industries, Inc.
    - e. Spence Engineering Company, Inc.
    - f. Watts Regulator Co.
  2. Body: Bronze or brass.
  3. Disc: Glass and carbon-filled PTFE.
  4. Seat: Brass.
  5. Stem Seals: EPDM O-rings.
  6. Diaphragm: EPT.
  7. Wetted, Internal Work Parts: Brass and rubber.
  8. Inlet Strainer: 304 or 316 stainless steel, removable without system shutdown.
  9. Valve Seat and Stem: Noncorrosive.
  10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.
- G. Automatic Flow-Control Valves:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. Flow Design Inc.
    - b. Griswold Controls.
    - c. Hays Fluid Controls
    - d. Macon
    - e. NuTech Hydronic Specialty Products
    - f. Nexus Valve, Inc.
  2. Valves shall be factory set to limit flow no higher than design maximum at a minimum range of valve differential pressure of [2 to 32] [4 to 57][2 to 80] psig
  3. Body: Brass, bronze or ferrous metal.
  4. Flow Limiting Assembly: Corrosion resistant stainless steel piston/spring or elastomeric diaphragm, tamper proof, self-cleaning, and removable.
  5. Combination Assemblies: Include bronze or brass ball valve.



6. Identification Tag: Marked with zone identification, valve number, and flow rate.
7. Size: Same as pipe in which installed.
8. Performance: Maintain constant flow, plus or minus 10 percent over system pressure fluctuations.
9. Minimum CWP Rating: **[175 psig] [300 psig]**.
10. Maximum Operating Temperature: **[200 deg F]**.

## **2.3 AIR-CONTROL DEVICES**

### **A. Manual Air Vents:**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
  - a. AMTROL, Inc.
  - b. Armstrong Pumps, Inc.
  - c. Bell & Gossett Domestic Pump.
  - d. Nexus Valve, Inc.
  - e. NuTech Hydronic Specialty Products
  - f. Taco, Inc.
2. Body: Bronze.
3. Internal Parts: Nonferrous.
4. Operator: Screwdriver or thumbscrew.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/8.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 225 deg F.

### **B. Bladder-Type Expansion Tanks:**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
  - a. AMTROL, Inc.
  - b. Armstrong Pumps, Inc.
  - c. Bell & Gossett Domestic Pump.
  - d. Taco, Inc.
2. Tank: Welded steel, rated for 125-psig working pressure and 240 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

### **C. In-Line Air Separators:**

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. AMTROL, Inc.
    - b. Armstrong Products, Inc.
    - c. Bell & Gossett Domestic Pump.
    - d. Taco, Inc.
  2. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
  3. Maximum Working Pressure: Up to 175 psig.
  4. Maximum Operating Temperature: Up to 300 deg F.
- D. Air Purgers:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. AMTROL, Inc.
    - b. Armstrong Pumps, Inc.
    - c. Bell & Gossett Domestic Pump.
    - d. Taco, Inc.
  2. Body: Cast iron with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal.
  3. Maximum Working Pressure: 150 psig.
  4. Maximum Operating Temperature: 250 deg F.

## **2.4 HYDRONIC PIPING SPECIALTIES**

- A. Stainless-Steel Bellow, Flexible Connectors:
1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
  2. End Connections: Threaded or flanged to match equipment connected.
  3. Performance: Capable of 3/4-inch misalignment.
  4. CWP Rating: 150 psig.
  5. Maximum Operating Temperature: 250 deg F.
- B. Expansion Fittings: Comply with requirements in Division 23.

## **PART 3 - EXECUTION**

### **3.1 VALVE APPLICATIONS**

- A. Install shut off-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
- B. Install calibrated-orifice, balancing valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

### **3.2 HYDRONIC SPECIALTIES INSTALLATION**

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- C. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.
- D. Install expansion tanks. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
  - 1. Install tank fittings that are shipped loose.
  - 2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.
- E. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

**END OF SECTION**

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## **SECTION 23 21 23 - HYDRONIC PUMPS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Close-coupled, in-line centrifugal pumps.
  - 2. Close-coupled, end-suction centrifugal pumps.
  - 3. Separately coupled, base-mounted, end-suction centrifugal pumps.
  - 4. Automatic condensate pump units.

#### **1.3 DEFINITIONS**

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: For each pump.
  - 1. Show pump layout and connections.
  - 2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
  - 3. Include diagrams for power, signal, and control wiring.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.
- B. Final shop drawings.
- C. Results of pump alignment procedures.
- D. Results of pump startup procedures.

## 1.6 MAINTENANCE MATERIAL SUBMITTALS

- 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. Mechanical Seals: One mechanical seal(s) for each pump.

## 1.7 WARRANTY

- A. Special Warranty: Manufacturer shall repair or replace equipment and all components provided with equipment.
  - 1. Warranty Period: 5 years from the date of substantial completion.

## PART 2 - PRODUCTS

### 2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - 1. TACO Incorporated
  - 2. Armstrong Pumps Inc.
  - 3. Bell & Gossett.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump; designed for installation with pump and motor shafts mounted horizontally or vertically.
- C. Pump Construction:
  - 1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet and flanged connections.
  - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
  - 3. Pump Shaft: Steel, with copper-alloy shaft sleeve or Stainless steel.
  - 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
  - 5. Pump Bearings: regreaseable lubricated ball-bearings rated for an average life of L-10, 200,000 hours.
- D. Motor: Single speed and rigidly mounted to pump casing.
  - 1. 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.
  - 2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23, Common Motor Requirements for HVAC Equipment.
    - a. Enclosure: Totally enclosed, fan cooled.
    - b. Enclosure Materials: Cast iron or cast steel.
    - c. Motor Bearings: Grease-lubricated ball bearings.
    - d. Efficiency: Premium efficient.
    - e. NEMA Design: Class B, suitable for inverter duty.

- f. Service Factor: 1.15.
- 3. Refer to Section 23 05 13 for Common Motor Requirements.

## **2.2 CLOSE-COUPLED, END-SUCTION CENTRIFUGAL PUMPS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - 1. TACO Incorporated
  - 2. Armstrong Pumps Inc.
  - 3. Bell & Gossett.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, end-suction pump; designed for installation with pump and motor shafts mounted horizontally.
- C. Pump Construction:
  - 1. Casing: Radially split, cast iron, with drain plug at bottom and air vent at top of volute, threaded gage tappings at inlet and outlet, and flanged connections.
  - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
  - 3. Pump Shaft: Steel, with copper-alloy shaft sleeve or Stainless steel.
  - 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
  - 5. Pump Bearings: Regreaseable lubricated ball-bearings rated for an average life of L-10, 200,000 hours.
- D. Motor: Single speed and rigidly mounted to pump casing with integral pump support.
  - 1. 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.
  - 2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23, Common Motor Requirements for HVAC Equipment.
    - a. Enclosure: Totally enclosed, fan cooled.
    - b. Enclosure Materials: Cast iron or cast steel.
    - c. Motor Bearings: Grease-lubricated ball bearings.
    - d. Efficiency: Premium efficient.
    - e. NEMA Design: Class B, suitable for inverter duty.
    - f. Service Factor: 1.15.
  - 3. Refer to Section 23 05 13 for Common Motor Requirements.

## **2.3 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
  - 1. TACO Incorporated
  - 2. Armstrong Pumps Inc.
  - 3. Bell & Gossett.

- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump; designed for base mounting, with pump and motor shafts horizontal.
- C. Pump Construction:
  - 1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
  - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
  - 3. Pump Shaft: Steel, with copper-alloy shaft sleeve or Stainless steel.
  - 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
  - 5. Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
  - 6. Pump Bearings: Regreasable lubricated ball-bearings rated for an average life of L-10, 200,000 hours.
- D. Shaft Coupling: Molded-rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor. EPDM coupling sleeve for variable-speed applications.
- E. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- G. Motor: Single speed, secured to mounting frame, with adjustable alignment.
  - 1. 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.
  - 2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23, Common Motor Requirements for HVAC Equipment.
    - a. Enclosure: Totally enclosed, fan cooled.
    - b. Enclosure Materials: Cast iron or cast steel.
    - c. Motor Bearings: Grease-lubricated ball bearings.
    - d. Efficiency: Premium efficient.
    - e. NEMA Design: Class B, suitable for inverter duty.
    - f. Service Factor: 1.15.
  - 3. Refer to Division 23.

## 2.4 AUTOMATIC CONDENSATE PUMP UNITS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
  - 1. Hartell Pumps Div.; Milton Roy Co.

- B. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch- minimum, electrical power (hard-wire).

## **2.5 PUMP SPECIALTY FITTINGS**

- A. Suction Diffuser:
  - 1. Angle pattern.
  - 2. 175-psig (1204-kPa) pressure rating, cast-iron body and end cap, pump-inlet fitting.
  - 3. Bronze startup and bronze or stainless-steel permanent strainers.
  - 4. Bronze or stainless-steel straightening vanes.
  - 5. Drain plug.
  - 6. Factory-fabricated support.
  - 7. Shall be full pipe line size with a separate reducer to pump inlet connection.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PUMP INSTALLATION**

- A. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- B. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- C. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.
- D. Equipment Mounting: Install base mounted pumps on cast-in-place concrete pads and inertia bases. Refer to Division 23.
  - 1. Coordinate sizes and locations of concrete bases with actual equipment provided.
  - 2. Construct bases to withstand, without damage to equipment, seismic force required by code.
  - 3. Construct concrete bases 4 inches (100 mm) high and extend base not less than 6 inches (150 mm) in all directions beyond the maximum dimensions of base-mounted pumps unless otherwise indicated or unless required for seismic-anchor support.
- E. Install in-line pumps with continuous-thread hanger rods and spring hangers with vertical-limit stop of size required to support weight of in-line pumps. Refer to Section 23 05 48 for Vibration Isolation



1. Comply with requirements for seismic-restraint devices specified in Division 23.
2. Comply with requirements for hangers and supports specified in Division 23

### **3.3 ALIGNMENT**

- A. Perform alignment service.
- B. Comply with requirements in Hydronics Institute standards for alignment of pump and motor shaft. Add shims to the motor feet and bolt motor to base frame. Do not use grout between motor feet and base frame.
- C. Comply with pump and coupling manufacturers' written instructions.
- D. After alignment is correct, tighten foundation bolts evenly but not too firmly. Completely fill baseplate with nonshrink, nonmetallic grout while metal blocks and shims or wedges are in place. After grout has cured, fully tighten foundation bolts.
- E. The results of pump alignment services shall be reported in writing and submitted with startup documentation.

### **3.4 CONNECTIONS**

- A. Comply with requirements for hydronic piping specified in Division 23. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to pump, allow space for service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes as per plans with reducers to pump nozzles.
- E. Install check valve and throttling valve with memory stop on discharge side of pumps.
- F. Install pipe line size suction diffuser and shutoff valve on suction side of pumps.
- G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- H. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.
- I. Install check valve and gate or ball valve on each condensate pump unit discharge.
- J. Ground equipment according to Division 26.
- K. Connect wiring according to Division 26.

### **3.5 STARTUP SERVICE**

- A. Perform startup service.
  1. Complete installation and startup checks according to manufacturer's written instructions.
  2. Check piping connections for tightness.
  3. Clean strainers on suction piping.

4. Perform the following startup checks for each pump before starting:
    - a. Verify bearing lubrication.
    - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    - c. Verify that pump is rotating in the correct direction.
  5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
  6. Start motor.
  7. Open discharge valve slowly.
- B. Submit report showing results of startup procedures.

### **3.6 DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

**END OF SECTION**

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## **SECTION 23 22 13 - STEAM AND CONDENSATE HEATING PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following for LP steam and condensate piping:
  - 1. Pipe and fittings.
  - 2. Strainers.
  - 3. Flash tanks.
  - 4. Safety valves.
  - 5. Steam traps.
  - 6. Thermostatic air vents and vacuum breakers.

#### **1.3 DEFINITIONS**

- A. LP Systems: Low-pressure piping operating at 15 psig (104 kPa) or less as required by ASME B31.9.

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. Components and installation shall be capable of withstanding the following minimum design pressures:
  - 1. LP and Condensate Steam Piping: 150 psig.
  - 2. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
  - 3. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of the following:
  - 1. Safety valve.
  - 2. Steam trap.
  - 3. Air vent and vacuum breaker.
  - 4. Flash tank.
- B. Shop Drawings: Detail, 1/4 inch equals 1 foot (1:50) scale, flash tank assemblies and fabrication of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops.

## **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Welding certificates.
- C. Field quality-control test reports.

## **1.7 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For valves, safety valves, steam traps, air vents and vacuum breakers, to include in emergency, operation, and maintenance manuals.

## **1.8 QUALITY ASSURANCE**

- A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."
- B. Pipe Welding: Qualify processes and operators according to the following:
  - 1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
  - 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.
- C. ASME Compliance: Comply with ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

## **PART 2 - PRODUCTS**

### **2.1 COPPER TUBE AND FITTINGS**

- A. Annealed-Temper Copper Tubing: ASTM B 88, Type K (ASTM B 88M, Type A).
- B. Wrought-Copper Fittings and Unions: ASME B16.22.

### **2.2 STEEL PIPE AND FITTINGS**

- A. Steel Pipe: ASTM A 53/A 53M, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 as indicated in Part 3 piping applications articles.
- C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 as indicated in Part 3 piping applications articles.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, as indicated in Part 3 piping applications articles.

- E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
  - 1. Material Group: 1.1.
  - 2. End Connections: Butt welding.
  - 3. Facings: Raised face.
- H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.
- I. Stainless-Steel Bellows, Flexible Connectors:
  - 1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
  - 2. End Connections: Threaded or flanged to match equipment connected.
  - 3. Performance: Capable of 3/4-inch (20-mm) misalignment.
  - 4. CWP Rating: 150-psig (1035-kPa).
  - 5. Maximum Operating Temperature: 250 deg F (121 deg C).

### **2.3 JOINING MATERIALS**

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BA9-1, silver alloy for joining copper with bronze or steel.
- E. Welding Filler Metals: Comply with AWS D10.12 (AWS D10.12M) for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- F. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

### **2.4 DIELECTRIC FITTINGS**

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. Capitol Manufacturing Company.
    - b. Central Plastics Company.
    - c. Hart Industries, International Inc.
    - d. Watts Water Technologies, Inc.
    - e. Zurn Plumbing Products Group.
  2. Factory-fabricated union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
- D. Dielectric Flanges:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. Capitol Manufacturing Company.
    - b. Central Plastics Company.
    - c. Watts Water Technologies, Inc.
  2. Factory-fabricated companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
- E. Dielectric-Flange Kits:
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:
  2. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Central Plastics Company.
    - d. Pipeline Seal and Insulator, Inc.
  3. Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.
  4. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

## 2.5 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 23, General-Duty Valves for HVAC Piping.
- B. Stop-Check Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
    - a. Crane Co.
    - b. Jenkins Valves; a Crane Company.
    - c. Lunkenheimer Valves.
    - d. A.Y. McDonald Mfg. Co.
  2. Body and Bonnet: Malleable iron.
  3. End Connections: Flanged.

4. Disc: Cylindrical with removable liner and machined seat.
5. Stem: Brass alloy.
6. Operator: Outside screw and yoke with cast-iron handwheel.
7. Packing: Polytetrafluoroethylene-impregnated packing with two-piece packing gland assembly.
8. Pressure Class: 250.

## 2.6 STRAINERS

### A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B cast iron (cast steel for high pressure steam), with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2 (DN 50) and smaller; flanged ends for strainers NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: Stainless-steel, 20 mesh strainer (for 2-inch and smaller), and perforated stainless-steel basket with 50 percent free area.
4. Tapped blowoff plug.
5. CWP Rating: 250-psig (1725-kPa) working steam pressure.

### B. Basket Strainers:

1. Body: ASTM A 126, Class B cast iron (cast steel for high pressure steam), with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for strainers NPS 2 (DN 50) and smaller; flanged ends for strainers NPS 2-1/2 (DN 65) and larger.
3. Strainer Screen: Stainless-steel, 20 mesh strainer, and perforated stainless-steel basket with 50 percent free area.
4. CWP Rating: 250-psig (1725-kPa) working steam pressure.

## 2.7 FLASH TANKS

- A. Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code, for 150-psig (1035-kPa) rating; and bearing ASME label. Fabricate with tapplings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

## 2.8 SAFETY VALVES

### A. Bronze or Brass Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - a. Armstrong International, Inc.
  - b. Kunkle Valve; a Tyco International Ltd. Company.
  - c. Spirax Sarco, Inc.
  - d. Watts Water Technologies, Inc.
2. Disc Material: Forged copper alloy.
3. End Connections: Threaded inlet and outlet.
4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.

7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

B. Cast-Iron Safety Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - a. Armstrong International, Inc.
  - b. Kunkle Valve; a Tyco International Ltd. Company.
  - c. Spirax Sarco, Inc.
  - d. Watts Water Technologies, Inc.
2. Disc Material: Forged copper alloy with bronze nozzle.
3. End Connections: Raised-face flanged inlet and threaded or flanged outlet connections.
4. Spring: Fully enclosed cadmium-plated steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.
6. Drip-Pan Elbow: Cast iron and having threaded inlet, outlet, and drain, with threads complying with ASME B1.20.1.
7. Exhaust Head: Cast iron and having threaded inlet and drain, with threads complying with ASME B1.20.1.
8. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

## 2.9 STEAM TRAPS

A. Thermostatic Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - a. Armstrong International, Inc.
  - b. Barnes & Jones, Inc.
  - c. Dunham-Bush, Inc.
  - d. Hoffman Specialty; Division of ITT Industries.
  - e. Spirax Sarco, Inc.
  - f. Sterling.
2. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
3. Trap Type: Balanced-pressure.
4. Bellows: Stainless steel or monel.
5. Head and Seat: Replaceable, hardened stainless steel.
6. Pressure Class: 125.

B. Float and Thermostatic Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - a. Armstrong International, Inc.
  - b. Barnes & Jones, Inc.
  - c. Dunham-Bush, Inc.
  - d. Hoffman Specialty; Division of ITT Industries.
  - e. Spirax Sarco, Inc.
  - f. Sterling.



2. Body and Bolted Cap: ASTM A 126, cast iron.
3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel.
5. Head and Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F (25 deg C) of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless steel cage, valve, and seat.
10. Maximum Operating Pressure: 125 psig (860 kPa).

C. Inverted Bucket Traps:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - a. Armstrong International, Inc.
  - b. Barnes & Jones, Inc.
  - c. Dunham-Bush, Inc.
  - d. Hoffman Specialty; Division of ITT Industries.
  - e. Spirax Sarco, Inc.
  - f. Sterling.
2. Body and Cap: Cast iron.
3. End Connections: Threaded.
4. Head and Seat: Stainless steel.
5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
6. Bucket: Brass or stainless steel.
7. Strainer: Integral stainless-steel inlet strainer within the trap body.
8. Air Vent: Stainless-steel thermostatic vent.
9. Pressure Rating: 250 psig (1725 kPa).

## 2.10 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - a. Armstrong International, Inc.
  - b. Barnes & Jones, Inc.
  - c. Dunham-Bush, Inc.
  - d. Hoffman Specialty; Division of ITT Industries.
  - e. Spirax Sarco, Inc.
  - f. Sterling.
2. Body: Cast iron, bronze or stainless steel.
3. End Connections: Threaded.
4. Float, Valve, and Seat: Stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
6. Pressure Rating: 125 psig (861 kPa).
7. Maximum Temperature Rating: 350 deg F (177 deg C).

B. Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - a. Armstrong International, Inc.
  - b. Dunham-Bush, Inc.
  - c. Hoffman Specialty; Division of ITT Industries.
  - d. Johnson Corporation (The).
  - e. Spirax Sarco, Inc.
2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
5. O-ring Seal: EPR.
6. Pressure Rating: 125 psig (861 kPa).
7. Maximum Temperature Rating: 350 deg F (177 deg C).

## **PART 3 - EXECUTION**

### **3.1 LP STEAM PIPING APPLICATIONS**

- A. LP Steam Piping, NPS 2 (DN 50) and Smaller: Schedule 40, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
- B. LP Steam Piping, NPS 2-1/2 through NPS 12 (DN 65 through DN 300): Schedule 40, Type E, all welded.
- C. Condensate piping above grade, NPS 2 (DN 50) and smaller, shall be the following:
  1. Schedule 80, Type S, Grade B, steel pipe; Class 125 cast-iron fittings; and threaded joints.
- D. Condensate piping above grade, NPS 2-1/2 (DN 65) and larger, shall be the following:
  1. Schedule 80, Type E, Grade B, steel pipe; Class 150 wrought-steel fittings, flanges, and flange fittings; and welded and flanged joints.

### **3.2 ANCILLARY PIPING APPLICATIONS**

- A. Air Vent Piping
  1. Inlet: Same as service where installed.
  2. Outlet: Type K (A) annealed-temper copper tubing with soldered or flared joints.
- B. Vacuum-Breaker Piping: Outlet, same as service where installed.
- C. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

### **3.3 VALVE APPLICATIONS**

- A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

- B. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

### **3.4 PIPING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping free of sags and bends.
- G. Install fittings for changes in direction and branch connections.
- H. Install piping to allow application of insulation.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- K. Install drains, consisting of a tee fitting, NPS 3/4 (DN 20) full port-ball valve, and short NPS 3/4 (DN 20) threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.
- M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.
- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.
- P. Install valves according to Division 23, General-Duty Valves for HVAC Piping.
- Q. Install unions in piping, NPS 2 (DN 50) and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

- R. Install flanges in piping, NPS 2-1/2 (DN 65) and larger, at final connections of equipment and elsewhere as indicated.
- S. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 (DN 20) nipple and full port ball valve in blowdown connection of strainers NPS 2 (DN 50) and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2 (DN 50).
- T. Install expansion loops, anchors, and pipe alignment guides as specified in Division 23, Expansion Fittings and Loops for HVAC Piping.
- U. Identify piping as specified in Division 23, Identification for HVAC Piping and Equipment.
- V. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.
  - 1. On straight runs with no natural drainage points, install drip legs at intervals not exceeding 150.
  - 2. Size drip legs same size as main. In steam mains NPS 6 (DN 150) and larger, drip leg size can be reduced, but to no less than NPS 4 (DN 100).
- W. Flash Tank:
  - 1. Pitch condensate piping down toward flash tank.
  - 2. If more than one condensate pipe discharges into flash tank, install a check valve in each line.
  - 3. Install thermostatic air vent at tank top.
  - 4. Install safety valve at tank top.
  - 5. Install full-port ball valve, and swing check valve on condensate outlet.
  - 6. Install inverted bucket or float and thermostatic trap at low-pressure condensate outlet, sized for three times the calculated heat load.
  - 7. Install pressure gage on low-pressure steam outlet according to Division 23, Meters and Gages for HVAC Piping.
- X. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23, Sleeves and Sleeve Seals for HVAC Piping.
- Y. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23, Sleeves and Sleeve Seals for HVAC Piping.
- Z. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23, Escutcheons for HVAC Piping.

### **3.5 STEAM-TRAP INSTALLATION**

- A. Install steam traps in accessible locations as close as possible to connected equipment.
- B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.
- C. Install thermostatic steam traps to drain condensate from steam radiation units and convectors.
- D. Install F&T traps to drain condensate from unit heaters, convectors, heating coils, steam separators, flash tanks, heat exchangers, humidifiers, and piping.

### **3.6 SAFETY VALVE INSTALLATION**

- A. Install safety valves according to ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping."
- B. Pipe safety-valve discharge without valves to atmosphere outside the building.
- C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.
- D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2 (DN 65).

### **3.7 HANGERS AND SUPPORTS**

- A. Install hangers and supports according to Division 23, Hangers and Supports for HVAC Piping and Equipment.
- B. Seismic restraints are specified in Division 23, Vibration and Seismic Controls for HVAC Piping and Equipment.
- C. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet (6 m) long.
  - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet (6 m) or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
- D. Support vertical runs at roof, at each floor, and at 10-foot (3-m) intervals between floors.

### **3.8 PIPE JOINT CONSTRUCTION**

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube ends. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints according to AWS D10.12 (AWS D10.12M), using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

### **3.9 TERMINAL EQUIPMENT CONNECTIONS**

- A. Size for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install traps and control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install vacuum breakers downstream from control valve, close to coil inlet connection.
- E. Install a drip leg at coil outlet.

### **3.10 FIELD QUALITY CONTROL**

- A. Prepare steam and condensate piping according to ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping," and as follows:
  - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
  - 2. Flush system with clean water. Clean strainers.
  - 3. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
- B. Perform the following tests on steam and condensate piping:
  - 1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
  - 2. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength.
  - 3. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
- C. Prepare written report of testing.

### **END OF SECTION 23 22 13**

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## SECTION 23 22 16 - STEAM AND CONDENSATE PIPING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes the following piping specialties for [LP] steam and condensate piping:
  - 1. Flash tanks.
  - 2. Steam traps.
  - 3. Thermostatic air vents and vacuum breakers.
  - 4. Steam and condensate meters.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
  - 1. Steam trap.
  - 2. Air vent and vacuum breaker.
  - 3. Meter.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

#### 1.5 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to the following:
  - 1. ASME Compliance: Pressure vessels shall bear the appropriate ASME label.

### PART 2 - PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:
  - 1. LP Steam Piping: <15 psig>.
  - 2. Condensate Piping: <Insert 15 psig> at [250 deg F].
  - 3. Makeup-Water Piping: [80 psig] at [150 deg F] .
  - 4. Blowdown-Drain Piping: Equal to pressure of the piping system to which it is attached.

5. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.

## **2.2 VALVES**

- A. Gate, Globe, Check, and Ball Valves: Comply with requirements specified in Division 23.
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. A.Y. McDonald Mfg. Co.
    - b. Cincinnati Valve Company.
    - c. Crane; Crane Energy Flow Solutions.
    - d. Jenkins Valves.
  2. Body and Bonnet: Malleable iron.
  3. End Connections: Flanged.
  4. Disc: Cylindrical with removable liner and machined seat.
  5. Stem: Brass alloy.
  6. Operator: Outside screw and yoke with cast-iron handwheel.
  7. Packing: Polytetrafluoroethylene-impregnated packing with two-piece packing gland assembly.
  8. Pressure Class: 150.

## **2.3 STEAM TRAPS**

- A. Thermostatic Traps:
  1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. Armstrong International, Inc.
    - b. Barnes & Jones, Inc.
    - c. Dunham-Bush, Inc.
    - d. Hoffman Specialty.
    - e. Spirax Sarco, Inc.
    - f. Sterling.
  2. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.
  3. Trap Type: Balanced-pressure.
  4. Bellows: Stainless steel or monel.
  5. Head and Seat: Replaceable, hardened stainless steel.
  6. Pressure Class: 125.
- B. Thermodynamic Traps:



1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. Armstrong International, Inc.
    - b. Barnes & Jones, Inc.
    - c. Dunham-Bush, Inc.
    - d. Hoffman Specialty.
    - e. Spirax Sarco, Inc.
  2. Body: Stainless steel with screw-in cap.
  3. End Connections: Threaded.
  4. Disc and Seat: Stainless steel.
  5. Maximum Operating Pressure: 600 psig.
- C. Float and Thermostatic Traps:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. Armstrong International, Inc.
    - b. Barnes & Jones, Inc.
    - c. Dunham-Bush, Inc.
    - d. Hoffman Specialty.
    - e. Spirax Sarco, Inc.
    - f. Sterling.
  2. Body and Bolted Cap: ASTM A 126, cast iron.
  3. End Connections: Threaded.
  4. Float Mechanism: Replaceable, stainless steel.
  5. Head and Seat: Hardened stainless steel.
  6. Trap Type: Balanced pressure.
  7. Thermostatic Bellows: Stainless steel or monel.
  8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
  9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless-steel cage, valve, and seat.
  10. Maximum Operating Pressure: 125 psig.
- D. Inverted Bucket Traps:
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. Armstrong International, Inc.
    - b. Barnes & Jones, Inc.

- c. Dunham-Bush, Inc.
  - d. Hoffman Specialty.
  - e. Spirax Sarco, Inc.
  - f. Sterling.
2. Body and Cap: Cast iron.
  3. End Connections: Threaded.
  4. Head and Seat: Stainless steel.
  5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
  6. Bucket: Brass or stainless steel.
  7. Strainer: Integral stainless-steel inlet strainer within the trap body.
  8. Air Vent: Stainless-steel thermostatic vent.
  9. Pressure Rating: 250 psig.

## 2.4 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

### A. Thermostatic Air Vents:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
  - a. Armstrong International, Inc.
  - b. Barnes & Jones, Inc.
  - c. Dunham-Bush, Inc.
  - d. Hoffman Specialty.
  - e. Spirax Sarco, Inc.
  - f. Sterling.
2. Body: Cast iron, bronze, or stainless steel.
3. End Connections: Threaded.
4. Float, Valve, and Seat: Stainless steel.
5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
6. Pressure Rating: [125 psig] [300 psig] <Insert value>.
7. Maximum Temperature Rating: [350 deg F] <Insert temperature>.

### B. Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
  - a. Armstrong International, Inc.
  - b. Dunham-Bush, Inc.
  - c. Hoffman Specialty.
  - d. Johnson Corporation (The).

- e. Spirax Sarco, Inc.
- 2. Body: Cast iron, bronze, or stainless steel.
- 3. End Connections: Threaded.
- 4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
- 5. O-Ring Seal: EPR.
- 6. Pressure Rating: [125 psig] [300 psig] <Insert value>.
- 7. Maximum Temperature Rating: [350 deg F] <Insert temperature>.

## 2.5 FLEXIBLE CONNECTORS

### A. Stainless-Steel Bellows, Flexible Connectors:

- 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
  - a. Duraflex, Inc.
  - b. Flexicraft Industries.
  - c. Hyspan Precision Products, Inc.
  - d. Mason Industries, Inc.
  - e. Metraflex Company (The).
  - f. Twin City Hose, Inc.
- 2. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, protective jacket.
- 3. End Connections: Threaded or flanged to match equipment connected.
- 4. Performance: Capable of 3/4-inch misalignment.
- 5. CWP Rating: 150 psig.
- 6. Maximum Operating Temperature: 250 deg F.

## 2.6 STEAM METERS

### A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:

- 1. EMCO Flow Systems.
- 2. ISTECH Corp.
- 3. Preso Meters.
- 4. Spirax Sarco, Inc.

### B. Meters shall have a microprocessor to display totalizer flow, flow rate, temperature, pressure, time, and date; alarms for high and low flow rate and temperature.

- 1. Computer shall have 4- to 20-mA or 2- to 10-V output for temperature, pressure, and contact closure for flow increments.
- 2. Independent timers to store four peak flow rates and total flow.
- 3. Interface compatible with central workstation described in Division 23.
- 4. Microprocessor Enclosure: NEMA 250, Type 4.

- C. Sensor: Venturi, of **[stainless-steel]** construction, for insertion in pipeline between flanges. At least 10:1 turndown with plus or minus 1 percent accuracy over full-flow range.

## 2.7 CONDENSATE METERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
  - 1. Lincoln Meter Company.
- B. Body: Cast iron, bronze, or brass.
- C. Turbine: Copper, brass, or stainless steel.
- D. Connections: Threaded for NPS 2 and smaller and flanged for NPS 2-1/2.
- E. Totalizer: Meters shall have a microprocessor to display flow, flow rate, time, and date; alarms for high and low flow rate, pressure, and temperature.
  - 1. Computer shall have 4- to 20-mA or 2- to 10-V output for temperature, pressure, and contact closure for flow increments.
  - 2. Independent timers to store four peak flow rates and total flow.
  - 3. Interface compatible with central workstation specified in Division 23.
  - 4. Microprocessor Enclosure: NEMA 250, Type 4.
- F. Pressure Rating: **[Atmospheric] <15 psig 103.5 kPa>**.
- G. Maximum Temperature Rating: **[250 deg F]**.

## PART 3 - EXECUTION

### 3.1 VALVE APPLICATIONS

- A. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

### 3.2 PIPING INSTALLATION

- A. Install piping to permit valve servicing.
- B. Install drains, consisting of a tee fitting, NPS 3/4 full port-ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- C. Install valves according to Division 23.
- D. Install unions in piping, **[NPS 2] <Insert pipe size>** and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- E. Install flanges in piping, **[NPS 2-1/2] <Insert pipe size>** and larger, at final connections of equipment and elsewhere as indicated.
- F. Install shutoff valve immediately upstream of each dielectric fitting.
- G. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

### 3.3 STEAM-TRAP INSTALLATION

- A. Install steam traps in accessible locations as close as possible to connected equipment.

- B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

### **3.4 STEAM OR CONDENSATE METER INSTALLATION**

- A. Install meters with lengths of straight pipe upstream and downstream according to steam meter manufacturer's written instructions.
- B. Provide data acquisition wiring. See Division 23.

### **3.5 TERMINAL EQUIPMENT CONNECTIONS**

- A. Install traps and control valves in accessible locations close to connected equipment.
- B. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- C. Install vacuum breakers downstream from control valve, close to coil inlet connection.

**END OF SECTION**

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## **SECTION 23 22 23 - STEAM CONDENSATE PUMPS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes steam condensate pumps.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated. Indicate pump's operating point on curves. Include receiver capacity and material.
- B. Shop Drawings: For each pump.
  - 1. Show pump layout and connections.
  - 2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
  - 3. Include diagrams for power, signal, and control wiring.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

### **PART 2 - PRODUCTS**

#### **2.1 SINGLE-STAGE, CENTRIFUGAL PUMPS WITH FLOOR-MOUNTED RECEIVER**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
  - 1. Alyan Pump Company; Div. of Hannmann Machinery Systems, Inc.
  - 2. Armstrong Fluid Handling; Div. of Armstrong International, Inc.
  - 3. Bell & Gossett
  - 4. ITT Corporation; Domestic Pump Division.
  - 5. Nicholson Steam Trap; a division of Spence Engineering Company, Inc.
  - 6. Pentair Pump Group.
  - 7. Roth Pump Company.
  - 8. Skidmore Pump.
  - 9. Spence Engineering Company, Inc.; Division of Circor International, Inc.
  - 10. Spirax-Sarco Inc.
  - 11. Sterling.

- B. Description: Factory-fabricated, packaged, electric-driven pumps; with receiver, pumps, controls, and accessories suitable for operation with steam condensate.
1. 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.
  2. ASME Compliance: Fabricate and label steam condensate receivers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- C. Configuration: **Duplex** floor-mounted pump with receiver and float switches; rated to pump 200 deg F steam condensate.
- D. Receiver:
1. Floor mounted.
  2. **Close-grained cast iron.**
  3. Externally adjustable float switches.
  4. Flanges for pump mounting.
  5. Water-level gage and dial thermometer.
  6. Pressure gage at pump discharge.
  7. Bronze fitting isolation valve between pump and receiver.
  8. Lifting eyebolts.
  9. Inlet vent and an overflow.
  10. Cast-iron inlet strainer with vertical self-cleaning bronze screen and large dirt pocket.
- E. Pumps:
1. Centrifugal, close coupled, vertical design.
  2. Permanently aligned.
  3. Bronze fitted.
  4. Replaceable bronze case ring.
  5. Mechanical seals rated at 250 deg F.
  6. Mounted on receiver flange.
- F. Motor:
1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23, Common Motor Requirements for HVAC Equipment.
  2. Enclosure: **Open, dripproof.**
  3. Motor Bearings: **Permanently lubricated** ball bearings.
  4. Efficiency: Premium efficient.
  5. NEMA Design: 3R.
  6. Service Factor: 1.15.
- G. Control Panel:
1. Factory wired between pumps and float switches, for single external electrical connection.
  2. Provide fused, control-power transformer if voltage exceeds 230 V ac.
  3. NEMA 250, **Type 3** enclosure with hinged door and grounding lug, mounted on pump.
  4. Motor controller for each pump.

5. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.
6. Manual lead-lag control to override electrical pump alternator and manually select the lead pump.
7. Momentary-contact "TEST" push button on cover for each pump.
8. Numbered terminal strip.
9. Disconnect switch.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- B. Support pumps and piping separately so piping is not supported by pumps.
- C. Install thermometers and pressure gages.
- D. Equipment Mounting: Install pumps on cast-in-place concrete equipment bases. Comply with requirements for equipment bases specified in **Division 03, Cast-in-Place Concrete**.
  1. Coordinate sizes and locations of concrete bases with actual equipment provided.
  2. Construct bases to withstand, without damage to equipment, seismic force required by code.
  3. Construct concrete bases **4 inches** high and extend base not less than 6 inches in all directions beyond the maximum dimensions of pumps unless otherwise indicated or unless required for seismic-anchor support.
  4. Minimum Compressive Strength: **3000 psi** at 28 days.
  5. Minimum Deflection: **1 inch**.
  6. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
  7. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of concrete base.
  8. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  9. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  10. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 11.

### **3.3 CONNECTIONS**

- A. Comply with requirements for piping specified in Division 23, Steam and Condensate Heating Piping. Drawings indicate general arrangement of piping, fittings, and specialties.



- B. Where installing piping adjacent to machine, allow space for service and maintenance.
- C. Install a globe and check valve and pressure gage before inlet of each pump and a gate and check valve at pump outlet.
- D. Pipe drain to nearest floor drain for overflow and drain piping connections.
- E. Install full-size vent piping to outdoors, terminating in 180-degree elbow at point above highest steam system connection or as indicated.
- F. Ground equipment according to Division 26, Grounding and Bonding for Electrical Systems.
- G. Connect wiring according to Division 26, Low-Voltage Electrical Power Conductors and Cables.

### **3.4 STARTUP SERVICE**

- A. **Engage a factory-authorized service representative to perform** startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Clean strainers.
  - 3. Set steam condensate pump controls.
  - 4. Set pump controls for automatic start, stop, and alarm operation.
  - 5. Perform the following preventive maintenance operations and checks before starting:
    - a. Set float switches to operate at proper levels.
    - b. Set throttling valves on pump discharge for specified flow.
    - c. Check motors for proper rotation.
    - d. Test pump controls and demonstrate compliance with requirements.
    - e. Replace damaged or malfunctioning pump controls and equipment.
    - f. Verify that pump controls are correct for required application.
  - 6. Start steam condensate pumps according to manufacturer's written startup instructions.

### **3.5 DEMONSTRATION**

- A. **Train** Owner's maintenance personnel to adjust, operate, and maintain steam condensate pumps.

**END OF SECTION**

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## **SECTION 23 23 00 - REFRIGERANT PIPING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes refrigerant piping used for air-conditioning applications. The following criteria shall be coordinate with and verified against manufacturer's instructions.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Line Test Pressure for Refrigerant R-410A:
  - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
  - 2. Suction Lines for Heat-Pump Applications: 535 psig.
  - 3. Hot-Gas and Liquid Lines: 535 psig.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
  - 1. Thermostatic expansion valves.
  - 2. Solenoid valves.
  - 3. Hot-gas bypass valves.
  - 4. Filter dryers.
  - 5. Strainers.
  - 6. Pressure-regulating valves.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
  - 1. Shop Drawing Scale: 1/4 inch equals 1 foot.
  - 2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Welding certificates.

- B. Field quality-control test reports.

## **1.6 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

## **1.7 QUALITY ASSURANCE**

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

## **1.8 PRODUCT STORAGE AND HANDLING**

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

## **1.9 COORDINATION**

- A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07, Roof Accessories.

## **PART 2 - PRODUCTS**

### **2.1 COPPER TUBE AND FITTINGS**

- A. Copper Tube: ASTM B 280, Type ACR or as per manufacturer's to design.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Solder Filler Metals: ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.
- E. Brazing Filler Metals: AWS A5.8.
- F. Flexible Connectors:
  - 1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.
  - 2. End Connections: Socket ends.
  - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
  - 4. Pressure Rating: Factory test at minimum 500 psig.
  - 5. Maximum Operating Temperature: 250 deg F.

### **2.2 STEEL PIPE AND FITTINGS**

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; Type, Grade, and wall thickness as selected in Part 3 piping applications articles.
- B. Wrought-Steel Fittings: ASTM A 234/A 234M, for welded joints.

- C. Steel Flanges and Flanged Fittings: ASME B16.5, steel, including bolts, nuts, and gaskets, bevel-welded end connection, and raised face.
- D. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- E. Flanged Unions:
  - 1. Body: Forged-steel flanges for NPS 1 to NPS 1-1/2 and ductile iron for NPS 2 to NPS 3. Apply rust-resistant finish at factory.
  - 2. Gasket: Fiber asbestos free.
  - 3. Fasteners: Four plated-steel bolts, with silicon bronze nuts. Apply rust-resistant finish at factory.
  - 4. End Connections: Brass tailpiece adapters for solder-end connections to copper tubing.
  - 5. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
  - 6. Pressure Rating: Factory test at minimum 400 psig.
  - 7. Maximum Operating Temperature: 330 deg F.
- F. Flexible Connectors:
  - 1. Body: Stainless-steel bellows with woven, flexible, stainless-steel-wire-reinforced protective jacket
  - 2. End Connections:
    - a. NPS 2 and Smaller: With threaded-end connections.
    - b. NPS 2-1/2 and Larger: With flanged-end connections.
  - 3. Offset Performance: Capable of minimum 3/4-inch misalignment in minimum 7-inch- long assembly.
  - 4. Pressure Rating: Factory test at minimum 500 psig.
  - 5. Maximum Operating Temperature: 250 deg F.

## 2.3 VALVES AND SPECIALTIES

- A. Diaphragm Packless Valves:
  - 1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.
  - 2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.
  - 3. Operator: Rising stem and hand wheel.
  - 4. Seat: Nylon.
  - 5. End Connections: Socket, union, or flanged.
  - 6. Working Pressure Rating: 500 psig.
  - 7. Maximum Operating Temperature: 275 deg F.
- B. Packed-Angle Valves:
  - 1. Body and Bonnet: Forged brass or cast bronze.
  - 2. Packing: Molded stem, back seating, and replaceable under pressure.
  - 3. Operator: Rising stem.
  - 4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
  - 5. Seal Cap: Forged-brass or valox hex cap.

6. End Connections: Socket, union, threaded, or flanged.
  7. Working Pressure Rating: 500 psig.
  8. Maximum Operating Temperature: 275 deg F.
- C. Check Valves:
1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
  2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
  3. Piston: Removable polytetrafluoroethylene seat.
  4. Closing Spring: Stainless steel.
  5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
  6. End Connections: Socket, union, threaded, or flanged.
  7. Maximum Opening Pressure: 0.50 psig.
  8. Working Pressure Rating: 500 psig.
  9. Maximum Operating Temperature: 275 deg F.
- D. Service Valves:
1. Body: Forged brass with brass cap including key end to remove core.
  2. Core: Removable ball-type check valve with stainless-steel spring.
  3. Seat: Polytetrafluoroethylene.
  4. End Connections: Copper spring.
  5. Working Pressure Rating: 500 psig.
- E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
1. Body and Bonnet: Plated steel.
  2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
  3. Seat: Polytetrafluoroethylene.
  4. End Connections: Threaded.
  5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter.
  6. Working Pressure Rating: 400 psig.
  7. Maximum Operating Temperature: 240 deg F.
  8. Manual operator.
- F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.
  2. Piston, Closing Spring, and Seat Insert: Stainless steel.
  3. Seat Disc: Polytetrafluoroethylene.
  4. End Connections: Threaded.
  5. Working Pressure Rating: 400 psig.
  6. Maximum Operating Temperature: 240 deg F.
- G. Thermostatic Expansion Valves: Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.

2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
  3. Packing and Gaskets: Non-asbestos.
  4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
  5. Superheat: Adjustable or Nonadjustable as determined by manufacturer.
  6. Reverse-flow option (for heat-pump applications).
  7. End Connections: Socket, flare, or threaded union.
  8. Working Pressure Rating: Manufacturer to determine.
- H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
  2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
  3. Packing and Gaskets: Non-asbestos.
  4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
  5. Seat: Polytetrafluoroethylene.
  6. Equalizer: Internal or External as determined by manufacturer.
  7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch conduit adapter, and ac coil with voltage to be determined by manufacturer.
  8. End Connections: Socket.
  9. Set Pressure: Manufacturer to determine.
  10. Throttling Range: Maximum 5 psig.
  11. Working Pressure Rating: 500 psig.
  12. Maximum Operating Temperature: 240 deg F.
- I. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
  2. Screen: 100-mesh stainless steel.
  3. End Connections: Socket or flare.
  4. Working Pressure Rating: 500 psig.
  5. Maximum Operating Temperature: 275 deg F.
- J. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.
  2. Drain Plug: Brass hex plug.
  3. Screen: 100-mesh monel.
  4. End Connections: Socket or flare.
  5. Working Pressure Rating: 500 psig.
  6. Maximum Operating Temperature: 275 deg F.
- K. Moisture/Liquid Indicators:
1. Body: Forged brass.
  2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
  3. Indicator: Color coded to show moisture content in ppm.

4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
  5. End Connections: Socket or flare.
  6. Working Pressure Rating: 500 psig.
  7. Maximum Operating Temperature: 240 deg F.
- L. Replaceable-Core Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
  2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
  3. Desiccant Media: Manufacturer to determine.
  4. Designed for reverse flow (for heat-pump applications).
  5. End Connections: Socket.
  6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
  7. Maximum Pressure Loss: Manufacturer to determine.
  8. Rated Flow: 20 tons
  9. Working Pressure Rating: 500 psig.
  10. Maximum Operating Temperature: 240 deg F.
- M. Permanent Filter Dryers: Comply with ARI 730.
1. Body and Cover: Painted-steel shell.
  2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
  3. Desiccant Media: Activated Manufacturer to determine.
  4. Designed for reverse flow (for heat-pump applications).
  5. End Connections: Socket.
  6. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
  7. Maximum Pressure Loss: Manufacturer to determine.
  8. Working Pressure Rating: 500 psig.
  9. Maximum Operating Temperature: 240 deg F.
- N. Mufflers:
1. Body: Welded steel with corrosion-resistant coating.
  2. End Connections: Socket or flare.
  3. Working Pressure Rating: 500 psig.
  4. Maximum Operating Temperature: 275 deg F.
- O. Receivers: Comply with ARI 495.
1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
  2. Comply with UL 207; listed and labeled by an NRTL.
  3. Body: Welded steel with corrosion-resistant coating.
  4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
  5. End Connections: Socket or threaded.
  6. Working Pressure Rating: 500 psig.

7. Maximum Operating Temperature: 275 deg F.
- P. Liquid Accumulators: Comply with ARI 495.
1. Body: Welded steel with corrosion-resistant coating.
  2. End Connections: Socket or threaded.
  3. Working Pressure Rating: 500 psig.
  4. Maximum Operating Temperature: 275 deg F.

## 2.4 REFRIGERANTS

- A. **Manufacturers:** Subject to compliance with requirements, provide products by one of the following or approved equivalent:
1. **Atofina Chemicals, Inc.**
  2. **DuPont Company; Fluorochemicals Div.**
  3. **Honeywell, Inc.; Genetron Refrigerants.**
  4. **INEOS Fluor Americas LLC.**
- B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

## PART 3 - EXECUTION

### 3.1 PIPING APPLICATIONS FOR REFRIGERANT R-410A

- A. Suction Lines NPS 1-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.
- B. Suction Lines NPS 3-1/2 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.
- C. Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with soldered joints.
- D. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.
- E. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with 95-5 tin-antimony soldered joints.
- F. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with Alloy HB soldered joints.
- G. Hot-Gas and Liquid Lines, and Suction Lines for Heat-Pump Applications NPS 2 to NPS 4: Schedule 40, black-steel and wrought-steel fittings with welded joints.
- H. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

### 3.2 VALVE AND SPECIALTY APPLICATIONS

- A. Install diaphragm packless or packed-angle valves in suction and discharge lines of compressor.
- B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.
- C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.
- D. Except as otherwise indicated, install diaphragm packless or packed-angle valves on inlet and outlet side of filter dryers.



- E. Install a full-sized, three-valve bypass around filter dryers.
- F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.
- G. Install thermostatic expansion valves as close as possible to distributors on evaporators.
  - 1. Install valve so diaphragm case is warmer than bulb.
  - 2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.
  - 3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.
- H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.
- I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:
  - 1. Solenoid valves.
  - 2. Thermostatic expansion valves.
  - 3. Hot-gas bypass valves.
  - 4. Compressor.
- K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.
- L. Install receivers sized to accommodate pump-down charge if recommended by manufacturer.
- M. Install flexible connectors at compressors.

### **3.3 PIPING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Division 23, Instrumentation and Control for HVAC and Division 23, Sequence of Operations for HVAC Controls for solenoid valve controllers, control wiring, and sequence of operation.

- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08, Access Doors and Frames if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in protective conduit where installed belowground.
- N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- O. Slope refrigerant piping as follows:
  - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  - 2. Install horizontal suction lines with a uniform slope downward to compressor.
  - 3. Install traps and double risers to entrain oil in vertical runs.
  - 4. Liquid lines may be installed level.
- P. When brazing or soldering, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23, Sleeves and Sleeve Seals for HVAC Piping.
- R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23, Escutcheons for HVAC Piping.

### **3.4 PIPE JOINT CONSTRUCTION**

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
  - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
  - 2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.
- E. Threaded Joints: Thread steel pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry-seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Steel pipe can be threaded, but threaded joints must be seal brazed or seal welded.
- G. Welded Joints: Construct joints according to AWS D10.12/D10.12M.
- H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

### **3.5 HANGERS AND SUPPORTS**

- A. Hanger, support, and anchor products are specified in Division 23, Hangers and Supports for HVAC Piping and Equipment.
- B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
  2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
  3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  4. Spring hangers to support vertical runs.
  5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
  2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
  3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.
  4. NPS 1-1/4: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  5. NPS 1-1/2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  6. NPS 2: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  7. NPS 2-1/2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
  8. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
  9. NPS 4: Maximum span, 12 feet; minimum rod size, 1/2 inch.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
  2. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
  3. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
  4. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
- E. Support multifloor vertical runs at least at each floor.

### **3.6 FIELD QUALITY CONTROL**

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
1. Comply with ASME B31.5, Chapter VI.
  2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
  3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
    - a. Fill system with nitrogen to the required test pressure.
    - b. System shall maintain test pressure at the manifold gage throughout duration of test.
    - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

### **3.7 SYSTEM CHARGING**

- A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter-dryer core in charging line.

### **3.8 ADJUSTING**

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
  1. Open shutoff valves in condenser water circuit.
  2. Verify that compressor oil level is correct.
  3. Open compressor suction and discharge valves.
  4. Open refrigerant valves except bypass valves that are used for other purposes.
  5. Check open compressor-motor alignment and verify lubrication for motors and bearings.
- E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

END OF SECTION

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## **SECTION 23 25 00 - HVAC WATER TREATMENT**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following HVAC water-treatment systems:
  - 1. Bypass chemical-feed equipment and controls.
  - 2. Chemical treatment test equipment.
  - 3. HVAC water-treatment chemicals.
  - 4. Makeup water softeners.

#### **1.3 DEFINITIONS**

- A. EEPROM: Electrically erasable, programmable read-only memory.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- C. TDS: Total dissolved solids.

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.
- B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. Closed hydronic systems, including chilled water, hot-water heating, and water energy recovery/pre-heat, shall have the following water qualities:
  - 1. pH: Maintain a value within 9.0 to 10.5.
  - 2. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
  - 3. Boron: Maintain a value within 100 to 200 ppm.
  - 4. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
  - 5. Soluble Copper: Maintain a maximum value of 0.20 ppm.
  - 6. TDS: Maintain a maximum value of 10 ppm.
  - 7. Ammonia: Maintain a maximum value of 20 ppm.
  - 8. Free Caustic Alkalinity: Maintain a maximum value of 20 ppm.
  - 9. Microbiological Limits:
    - a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.

- b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
- c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
- d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
- e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

## **1.5 ACTION SUBMITTALS**

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
  - 1. Bypass feeders.
  - 2. Water meters.
  - 3. Inhibitor injection timers.
  - 4. pH controllers.
  - 5. TDS controllers.
  - 6. Chemical solution tanks.
  - 7. Injection pumps.
  - 8. Chemical test equipment.
  - 9. Chemical material safety data sheets.
  - 10. Water softeners.
  - 11. Self-cleaning strainers.
- B. Shop Drawings: Pretreatment and chemical treatment equipment showing tanks, maintenance space required, and piping connections to HVAC systems. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Wiring Diagrams: Power and control wiring.

## **1.6 INFORMATIONAL SUBMITTALS**

- A. Field quality-control test reports.
- B. Other Informational Submittals:
  - 1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
  - 2. Water Analysis: Illustrate water quality available at Project site.

## **1.7 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

## **1.8 QUALITY ASSURANCE**

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.
- 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.

## **1.9 MAINTENANCE SERVICE**

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for chilled water system, hot-water system, energy recovery/pre-heat system. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:
1. Initial water analysis and HVAC water-treatment recommendations.
  2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
  3. Periodic field service and consultation.
  4. Customer report charts and log sheets.
  5. Laboratory technical analysis.
  6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
1. Ampion Corp.
  2. Anderson Chemical Co, Inc.
  3. Aqua-Chem, Inc.; Cleaver-Brooks Div.
  4. Barclay Chemical Co.; Water Management, Inc.
  5. Boland Trane Services
  6. GE Betz.
  7. GE Osmonics.
  8. H-O-H Chemicals, Inc.
  9. Metro Group. Inc. (The); Metropolitan Refining Div.
  10. ONDEO Nalco Company.
  11. Watcon, Inc.

### **2.2 MANUAL CHEMICAL-FEED EQUIPMENT**

- A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch (89-mm) fill opening in the top, and NPS 3/4 (DN 20) bottom inlet and top side outlet. Quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
1. Capacity: 5 gal. (19 L).
  2. Minimum Working Pressure: 125 psig (860 kPa).

### **2.3 STAINLESS-STEEL PIPES AND FITTINGS**

- A. Stainless-Steel Tubing: Comply with ASTM A 269, Type 316.
- B. Stainless-Steel Fittings: Complying with ASTM A 815/A 815M, Type 316, Grade WP-S.
- C. Two-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, carbon-filled TFE seats, threaded

body design with adjustable stem packing, threaded ends, and 250-psig (1725-kPa) SWP and 600-psig (4140-kPa) CWP ratings.

- D. Three-Piece, Full-Port, Stainless-Steel Ball Valves: ASTM A 351, Type 316 stainless-steel body; ASTM A 276, Type 316 stainless-steel stem and vented ball, threaded body design with adjustable stem packing, threaded ends, and 150-psig (1035-kPa) SWP and 600-psig (4140-kPa) CWP rating.

## **2.4 CHEMICAL TREATMENT TEST EQUIPMENT**

- A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounting cabinet for testing pH, TDS, inhibitor, chloride, alkalinity, and hardness; sulfite and testable polymer tests for high-pressure boilers, and oxidizing biocide test for open cooling systems.
- B. Sample Cooler:
  - 1. Tube: Sample.
    - a. Size: NPS 1/4 (DN 8) tubing.
    - b. Material: ASTM A 666, Type 316 stainless steel.
    - c. Pressure Rating: Minimum 2000 psig (13 790 kPa).
    - d. Temperature Rating: Minimum 850 deg F (454 deg C).
  - 2. Shell: Cooling water.
    - a. Material: ASTM A 666, Type 304 stainless steel.
    - b. Pressure Rating: Minimum 250 psig (1725 kPa).
    - c. Temperature Rating: Minimum 450 deg F (232 deg C).
- C. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
  - 1. Two-station rack for closed-loop systems.

## **2.5 CHEMICALS**

- A. Chemicals shall be as recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment, and that can attain water quality specified in Part 1 "Performance Requirements" Article.

## **PART 3 - EXECUTION**

### **3.1 WATER ANALYSIS**

- A. Perform an analysis of supply water to determine quality of water available at Project site.

### **3.2 INSTALLATION**

- A. Install chemical application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate.



- B. Install water testing equipment on wall near water chemical application equipment.
- C. Install interconnecting control wiring for chemical treatment controls and sensors.
- D. Mount sensors and injectors in piping circuits.
- E. Bypass Feeders: Install in closed hydronic systems, including chilled water, hot-water, and energy recovery/pre-heat, and equipped with the following:
  1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
  2. Install water meter in makeup water supply.
  3. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
  4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
  5. Install a swing check on inlet after the isolation valve.

### **3.3 CONNECTIONS**

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23, Hydronic Piping.
- D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 23, General-Duty Valves for HVAC Piping.
- E. Refer to Division 22, Domestic Water Piping Specialties for backflow preventers required in makeup water connections to potable-water systems.
- F. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.
- G. Ground equipment according to Division 26, Grounding and Bonding for Electrical Systems.
- H. Connect wiring according to Division 26, Low-Voltage Electrical Power Conductors and Cables.

### **3.4 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 installations, including connections, and to assist in testing.
- C. Tests and Inspections:

1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
  2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
  3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
  4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
  5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
  7. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
  8. Repair leaks and defects with new materials and retest piping until no leaks exist.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
  2. Steam System: ASTM D 1066.
  3. Acidity and Alkalinity: ASTM D 1067.
  4. Iron: ASTM D 1068.
  5. Water Hardness: ASTM D 1126.

### **3.5 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Division 01, Demonstration and Training.
- B. Training: Provide a "how-to-use" self-contained breathing apparatus video that details exact operating procedures of equipment.

**END OF SECTION 23 25 00**

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## **SECTION 23 31 13 - AIR DISTRIBUTION SYSTEMS-METAL DUCTS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Sheet metal materials.
  - 2. Rectangular ducts and fittings.
  - 3. Round and flat-oval ducts and fittings.
  - 4. Double wall plenums and connections to louvers.
  - 5. Single wall plenums and connections to louvers.
  - 6. Duct liner.
  - 7. Sealant and gaskets.
  - 8. Hangers and supports.
  - 9. Manual volume dampers.
  - 10. Fire dampers.
  - 11. Smoke dampers, combination fire and smoke dampers, corridor ceiling dampers.
  - 12. Flanged breakaway connectors.
  - 13. Duct silencers.
  - 14. Short radius elbow splitter vanes.
  - 15. Remote damper operators.
  - 16. Duct-mounted access doors.
  - 17. Flexible connectors.
  - 18. Flexible ducts.
  - 19. Duct accessory hardware.
  - 20. Air vent waveguides.
  - 21. Diffusers, registers and grilles.
- B. Related Sections:
  - 1. Division 08 for fixed and adjustable louvers and wall vents whether or not they are connected to ducts.
  - 2. Division 28 for duct-mounted fire and smoke detectors not provided as integral option with smoke and fire-smoke dampers.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Delegated Duct Construction Design: Unless noted otherwise duct construction including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with 2005 SMACNA "HVAC Duct Construction Standards - Metal and Flexible" Third Edition, performance and design criteria indicated in "Duct Schedule" Article.
  - 1. In addition to the above basic requirements, the following supplemental requirements apply to this project:

- a. Minimum sheet metal thickness for welded sections of ductwork shall meet the requirements identified in Part 2 of this Section.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in 2016 ASHRAE Standard 62.1 "Ventilation for Acceptable Indoor Air Quality".
- C. Structural Support of Air Distribution Systems
1. Install ducts with support systems indicated in Tables 5-1 through 5-3 and Figures 5-1 through 5-10 of SMACNA Duct Construction Manual.
    - a. Select hangers and supports to withstand the effects of gravity loads and stresses within limits and under conditions described in Tables 5-1 through 5-3 and Figures 5-1 through 5-10.
    - b. Horizontal duct shall have a support within 2 feet of each elbow and within 4 feet of each branch connection.
    - c. Upper attachments to structure shall have an allowable gravity load of 25 percent of the failure load (proof test).
  2. Maximum load from hangers attached to the underside of slabs shall be 250 pounds. If this criteria cannot be met due to field identified space or coordination constraints, submit formal request for interpretation (RFI) to structural design professional of record for review and approval before proceeding with the installation.
  3. Do not drill or cut notches or holes in any structural member without the express written approval of the structural design professional of record.
  4. Provide core openings. Submit a formal request for interpretation, identifying location of desired cores to the structural design professional of record for guidance and approval.
  5. Do not attach or suspend MEP components from metal decking.
  6. Survey location of concrete reinforcement before drilling for anchors in reinforced concrete walls, beams or slabs. Do not cut reinforcing bars during the drilling of anchors without the express written approval of the structural design professional of record.
  7. Provide patching of fireproofing removed or damaged during the attachment of suspended MEP components. Provide documentation that the patching maintains the performance of the fire proofing system.
  8. For steel frames, maximum load from hangers attached to steel beams shall be 400 pounds. If clamps or other attachments are made to fireproofed beams, remove ample fireproofing at the point of contact to ensure the attachment device is placed with proper edge distance to develop the required pressure ("bite") on the steel. Patch fireproofing after attachment device is in place. Arrange clamps to equally load each side of flange.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of the following products:
1. Liners and adhesives.
  2. Sealants and gaskets.
  3. Adhesives.
  4. Diffusers, registers and grilles.
  5. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
  6. Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
  7. Duct silencers, provide pressure drop, dynamic insertion loss data and breakout noise characteristics.
- B. Samples: for the smallest indicated size of each exposed diffuser, register and grille:
1. Each factory applied color finish.
  2. Each texture.
- C. Sustainable Design Submittals:

1. Product data showing compliance with 2016 ASHRAE Standard 62.1 "Ventilation for Acceptable Indoor Air Quality" sections identified below.
    - a. Documentation indicating that duct systems comply with Section 5 - "Systems and Equipment."
    - b. Duct-Cleaning Test Report: Documentation of work performed for compliance with Section 7.2.4 - "Ventilation System Start-up."
  2. Product Data: Documentation indicating that duct systems comply with 2016 ASHRAE/IES Standard 90.1 "Energy Standard for Buildings Except Low-Rise Residential Buildings", Section 6.4.4 - "HVAC System Construction and Insulation."
  3. Leakage Test Report: Documentation of work performed for compliance with 2016 ASHRAE/IES Standard 90.1 "Energy Standard for Buildings Except Low-Rise Residential Buildings", Section 6.4.4.2 - "Duct and Plenum Leakage." Leak test reports shall be submitted as a single comprehensive report for a complete system (e.g. supply, return, exhaust) and not as individual section by section reports.
- D. Shop Drawings: For air distribution systems - metal ducts:
1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
  2. Factory- and shop-fabricated ducts and fittings.
  3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
  4. Elevation of top of ducts.
  5. Dimensions of main duct runs from building grid lines.
  6. Fittings.
  7. Reinforcement and spacing.
  8. Seam and joint construction.
  9. Penetrations through fire-rated and other partitions.
  10. Equipment installation based on approved equipment submittals.
  11. Locations for duct accessories, including dampers, full length splitter vanes, access doors and panels.
  12. Hangers and supports, including methods for duct and building attachment and vibration isolation.
  13. Detail metal duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
    - a. Special fittings.
    - b. Manual volume damper installations.
    - c. Control-damper installations.
    - d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
    - e. Wiring Diagrams: For power, signal, and control wiring for smoke and fire-smoke dampers.
- E. Delegated-Design Submittal:
1. Sheet metal thicknesses.
  2. Joint and seam construction and sealing.
  3. Reinforcement details and spacing.
  4. Materials, fabrication, assembly, and spacing of hangers and supports.
  5. Design Calculations:
    - a. For each system provide calculation of duct leakage class required to meet specified system leakage in accordance with ASHRAE recommendations.
    - b. Calculations for selecting hangers and supports.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Air Distribution System Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
  - a. Lighting fixtures.
  - b. Air outlets and inlets (diffusers, registers and grilles).
  - c. Speakers.
  - d. Sprinklers.
  - e. Ceiling and duct access panels.
  - f. Perimeter moldings.
  - g. Ceiling suspension assembly members
  - h. Methods of attaching hangers to building structure
  - i. Size and location of initial access modules for acoustical tile.
  - j. Duct accessories requiring ceiling-mounted access panels and access doors with input from Installers of the items involved.
7. Refer to Division 20 for additional coordination drawing requirements.

B. Welding certificates.

C. Duct leakage factors and duct leakage fraction calculations based on installed duct sizes and final routing.

D. Field quality-control reports.

E. Source quality-control reports.

## **1.6 CLOSEOUT SUBMITTALS**

A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

B. Final duct leakage test reports

## **1.7 MAINTENANCE MATERIAL SUBMITTALS**

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

## **1.8 QUALITY ASSURANCE**

A. Comply with applicable requirements of the following performance standards and agencies as referenced in this section:

1. 2005 SMACNA "HVAC Duct Construction Standards - Metal and Flexible" Third Edition (SMACNA Duct Construction Manual). Comply with requirements only as the chapters, subchapters, sections, appendices, figures and/or tables of the standard are specifically referenced in Articles in this Section.
  - a. Nothing in this Section shall be interpreted to mean SMACNA Duct Construction Manual is adopted in its entirety.
2. 2012 SMACNA "HVAC Air Duct Leakage Test Manual" (SMACNA Leak Test Manual). Comply with requirements only as the chapters, subchapters, sections, appendices, figures and/or tables of the manual are explicitly referenced in the Articles in this Section.

- a. Nothing in this Section shall be interpreted to mean SMACNA Leak Test Manual is adopted in its entirety.
  - 3. 2008 SMACNA "Seismic Restraint Manual – Guidelines for Mechanical Systems" (SMACNA Seismic Restraint Manual).
  - 4. 2002 SMACNA "Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems – 5<sup>th</sup> Edition".
  - 5. 2015 NFPA 90A "Installation of Air Conditioning and Ventilation Systems" (NFPA 90A).
  - 6. 2016 ASHRAE "HVAC Systems and Equipment Handbook" (ASHRAE Systems Handbook).
  - 7. 2015 ASHRAE "HVAC Applications Handbook" (ASHRAE Applications Handbook).
  - 8. 2016 ASHRAE Standard 62.1 "Ventilation for Acceptable Indoor Air Quality" (ASHRAE 62.1).
  - 9. 2016 ASHRAE/IES Standard 90.1 "Energy Standard for Buildings Except Low-Rise Residential Buildings" (ASHRAE/IES 90.1).
  - 10. 2006 (RA2011) ASHRAE Standard 70 "Method of Testing the Performance of Air Outlets and Air Inlets" (ASHRAE 70).
  - 11. 2013 ASHRAE Standard 113 "Method of Testing for Room Air Diffusion" (ASHRAE 113).
  - 12. 2002 North American Insulation Manufacturers Association, "Fibrous Glass Duct Liner Standard AH124" Third Edition (NAIMA).
  - 13. 2013 National Air Duct Cleaning Association, "Assessment, Cleaning, Restoration of HVAC Systems" (NADCA).
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
    - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
    - 2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
  - C. AMCA Standard 510-D "Laboratory Methods of Testing Dampers for Rating."
  - D. American Society of Testing and Materials (ASTM) standards referenced in other Articles of this Section.
  - E. Underwriters Laboratory (UL) standards referenced in other Articles of this Section.
  - F. Nationally Recognized Testing Labs (NRTL).
  - G. Environmental Protection Agency (EPA).

## **PART 2 - PRODUCTS**

### **2.1 AIR DISTRIBUTION SYSTEM GENERAL REQUIREMENTS**

- A. Comply with NFPA 90A.
- B. Only as referenced in this Section, comply with SMACNA Duct Construction Manual requirements for acceptable materials, material thicknesses, duct sealing methods, and duct construction methods unless otherwise indicated in the Articles of this Section or on the Drawings.
  - 1. All metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

### **2.2 SHEETMETAL MATERIALS**

- A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
  - 1. Galvanized Coating Designation: G90 (Z275).
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.]
- B. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- C. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

### **2.3 RECTANGULAR DUCTS AND FITTINGS**

- A. General Material Thickness Requirements for Rectangular Duct: Unless otherwise indicated in the Articles of this Section or on the drawings, comply with SMACNA Duct Construction Manual, Tables 2-1 through 2-33 inclusive of the associated details and notes as they relate to acceptable material thicknesses based on duct dimension, static pressure class, reinforcement code and reinforcement spacing
1. Materials shall be as indicated in the Article "Duct Schedule" in Part 3 of this Section.
  2. The thicknesses indicated in Tables 2-1 through 2-33 in the SMACNA Duct Construction Manual shall be acceptable for galvanized steel, carbon steel, stainless steel, and PVC coated galvanized steel.
  3. If aluminum duct is specified, the thickness of the material shall be adjusted according to Tables 2-50 through 2-52 of the SMACNA Duct Construction Manual.
  4. In addition to the basic requirements of SMACNA Duct Construction Manual, minimum sheet metal thickness for welded section of ductwork shall be 16 gage and minimum metal thickness for welded elbows shall be 14 gage. Provide SMACNA thickness where duct pressure class requires heavier gage.]
- B. General Fabrication Requirements: Except as otherwise noted, comply with Sub-Chapter 2.1 "Introduction to the Rectangular Duct Construction Schedules" of the SMACNA Duct Construction Manual.
1. Coordinate duct wall thickness, seams, joints, joint spacing, support intervals, sealing requirements, reinforcement code, and reinforcement spacing based on the static pressure class, duct material, and duct dimensions indicated in the design documents.
  2. Joints and seams shall be formed and assembled with dimensions and proportions for a tight and secure assembly.
- C. Transverse Joints (Non-Welded):
1. For pressure class less than 3 inches of water column, select and fabricate joint types according to Figure 2.1, Tables 2-31 through 2-33 and Sub-Chapter 2.4 (except reference to Chapter 11) of the SMACNA Duct Construction Manual.
  2. For pressure classes 3 inches of water column and greater, mechanical joints shall be pre-manufactured joint systems.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
      - 1) Ductmate Industries, Inc.
      - 2) Ward Industries.
      - 3) Dyn Air - Nexus Flange System.
- D. Longitudinal Seams (Non-Welded):
1. For duct pressure class of 2 inches water column or less, select seam type and fabricate according to Figure 2.2 and Sub-Chapter 2.3 of the SMACNA Duct Construction Manual.
  2. For duct pressure classes 3 inches water column or greater provide Type L-1 Pittsburg Lock seams fabricated according to Figure 2.2 of the SMACNA Duct Construction Manual.
- E. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Unless otherwise indicated, select types and fabricate according to Figures 4.2 through 4.9 and Chart 4.1 of the SMACNA Duct Construction Manual.
1. Provide only the SMACNA fittings described in Part 3 of this specification, without substitution, as these fittings are the basis of design used to calculated system static



pressure losses and motor horsepower requirements. Substitutions from indicated fittings will not be accepted.

2. The following fittings, shown in Figures 4.2 through 4.9 and Chart 4.1 of the SMACNA Duct Construction Manual noted above, shall NOT be used.
  - a. Figure 4-2
    - 1) Type RE-2, RE-4, RE-7, RE-9 and R-10 elbows shall not be used.
  - b. Figure 4-3
    - 1) Turning vanes are not acceptable.
  - c. Figure 4-4
    - 1) Turning vanes are not acceptable.
  - d. Figure 4-5
    - 1) Type 2 is not acceptable.
    - 2) Optional square throat with turning vanes shown for Type 4A and 4B branch connections are not acceptable.
  - e. Figure 4-6
    - 1) Straight tap, butt flange or cinch-lick branch connections are not acceptable.
    - 2) Flanged or spin-in round connections without a bell-mouth or conical form are not acceptable.
  - f. Figure 4-8
    - 1) Figure D is not acceptable. Figure B is preferable, however, if an offset of this type (I.E. four 90 degree elbows) is needed, use type RE-3 or RE-8 elbows and short radius elbows with full length splitter vanes in accordance with Chart 4-1 and Figure 4-9.

F. Special Considerations for Double Wall Rectangular Ducts and Fittings

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
  - a. McGill AirFlow LLC.
  - b. MKT Metal Manufacturing.
  - c. Sheet Metal Connectors, Inc.
2. In addition to the requirements set forth in other Articles of this Section and except as otherwise noted, comply with the requirements of Chapter 8 of the SMACNA Duct Construction Manual.
3. The dimensions shown on the drawings are the inner duct dimensions. Fabricate ducts with the inner duct having the dimensions shown on the drawings.
4. Inner Duct: Minimum 0.028-inch (0.7-mm) perforated galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent.
5. Interstitial Insulation: Fibrous-glass liner complying with ASTM C1071, NFPA 90A; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  - a. Maximum Thermal Conductivity: 0.27 Btu x in./h / sf / deg F (0.039 W/m / K) at 75 deg F (24 deg C) mean temperature.
  - b. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
  - c. Coat insulation with antimicrobial coating.
  - d. Cover insulation with polyester film complying with UL 181, Class 1.]

## 2.4 ROUND AND FLAT-OVAL DUCTS AND FITTINGS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
1. Ductmate Industries, Inc.
  2. Linx Industries (formerly Lindab).
  3. McGill AirFlow LLC.
  4. SEMCO LLC.]

- B. General Material Thickness Requirements for Round and Flat Oval Duct: Unless otherwise indicated in the Articles of this Section or the drawings, comply with SMACNA Duct Construction Manual, Tables 3-4 through 3-13 for round and table 3-15 for flat oval duct inclusive of the associated details and notes as they relate to acceptable material thickness based on duct dimension, static pressure class, reinforcement class and stiffener spacing.
1. Materials shall be as indicated in the Article "Duct Schedule" in Part 3 of this Section.
  2. The thicknesses indicated in Tables 3-4 through 3-13 for round and Table 3-15 for flat oval duct in the SMACNA Duct Construction Manual shall be acceptable for galvanized steel, carbon steel, stainless steel, and PVC coated galvanized steel.
  3. If aluminum duct is specified, the thickness of the material shall be adjusted according to Table 3-14 of the SMACNA Duct Construction Manual.
- C. General Fabrication Requirements: Except as otherwise noted in the Articles of this Section or the Drawings, round duct fabrication shall comply with Sub-Chapter 3.1 (excluding sections S3.0, S3.3, S3.4, S3.5, S3.9 and S3.10) and flat oval duct shall comply with Sub-Chapter 3.3 (the reference to Chapter 11 in section S3.17 applies only as referenced and for the purposes of the requirements of section S3.17 in Sub-Chapter 3.3) of the SMACNA Duct Construction Manual.
1. Duct wall thickness, seams, joints, joint spacing, stiffener spacing, support intervals, sealing requirements and reinforcement class shall be coordinated by the Contractor, based on the static pressure class, duct material, and duct dimensions indicated in the design documents, to ensure a proper assembly.
  2. Joints and seams shall be formed and assembled with proper dimensions and proportions for a tight and secure assembly.
- D. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- E. Transverse Joints: Select and fabricate according to Figure 3.1 of the SMACNA Duct Construction Manual with the exception that draw-band joints and crimp type joints (RT-3 and RT-5 respectively) are not permitted.
1. Transverse Joints in Ducts Larger Than 60 Inches (1524 mm) in Diameter: Flanged.
- F. Longitudinal Seams: Select and fabricate seam types shown Figure 3-2 of the SMACNA Duct Construction Manual.
1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
  2. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.
- G. Tees and Laterals: Unless otherwise noted, select types and fabricate according to Figures 3-5 and 3-6 for round duct and Figure 3-7 for flat oval duct of the SMACNA Duct Construction Manual.
1. The following Tees and Laterals shown in Figures 3.5 through 3.7 shall not be used
    - a. Figure 3-5
      - 1) 90 degree tee fitting,
      - 1) 90 degree tap fitting
      - 2) 90 degree saddle tap
    - b. Figure 3-6
      - 1) Conical tee.
- H. Special Considerations for Double-Wall Round and Flat-Oval Ducts and Fittings
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. Linx Industries (formerly Lindab).
    - b. McGill AirFlow LLC.
    - c. SEMCO LLC.
    - d. Sheet Metal Connectors, Inc.

2. In addition to the requirements set forth in other Articles of this Section of the Specification and except as otherwise noted, outer ducts shall comply with the requirements of Chapter 8 of the SMACNA Duct Construction Manual based on static pressure class.
  - a. Transverse Joints: Select joint types and fabricate according to SMACNA Duct Construction Manual, Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA Duct Construction Manual.
  - b. Longitudinal Seams: Select seam types and fabricate according to SMACNA Duct Construction Manual, Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA Duct Construction Manual.
    - 1) Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
    - 2) Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.
  - c. Tees and Laterals: Select types and fabricate according to SMACNA Duct Construction Manual, Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA HVAC Duct Construction Manual.
3. Round ducts: Dimensions indicated on the drawings are the duct diameter the inner duct.
4. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.
5. Inner Duct: Minimum 0.028-inch (0.7-mm) perforated galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent] [solid sheet steel].
6. Interstitial Insulation: Fibrous-glass liner complying with ASTM C1071, NFPA 90A; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

## **2.5 DOUBLE WALL PLENUMS AND CONNECTIONS TO LOUVERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
  1. SEMCO
  2. DuraSystems Barrier, Inc.
  3. Industrial Noise Control, Inc.
- B. Performance Requirements: Manufactured plenums shall be constructed as an insulated rigid board double wall casing in accordance with SMACNA Duct Construction Manual, Chapter 9, Equipment and Casings.
- C. Minimum Inner Wall skin: 18 gauge galvanized, solid sheet.
- D. Minimum Outer Wall Skin: 22 gauge galvanized, solid sheet
- E. Wall panels and insulation shall be thickness required to meet specified thermal performance, minimum 4" thick. Provide with 18 gauge galvanized longitudinal stiffeners spaced a maximum of 16" apart for the full the depth of the wall.
- F. Insulation thickness shall be the full wall depth with a minimum density of 3 lb/cu.ft. rigid mineral-fiber insulation. Panel shall have a minimum insulation value specified in Division 23 HVAC insulation Section and shall have a flame spread index of no greater than 25 and smoke developed index no greater than 50 when tested in accordance with ASTM E 84 or UL 723.
- G. Panel openings for ductwork shall be provided by the panel manufacturer. All piping and conduit penetrations shall be field located, cut and sealed per wall manufacturer requirements.

- H. For plenums 36 inches deep and 80 inches high or larger, provide 30" wide x 72" high access doors, pre-hung type, constructed of minimum 18 gauge, galvanized, all welded door frame and minimum 18 gauge, galvanized solid exterior and interior skins enclosing insulation as specified for wall panels. Seals suitable to provide airtight seal shall be provided between door and frame. Provide continuous piano hinge. Latches shall be operable from both sides of door. For smaller plenums, provide double wall access door with dimensions 6 inches smaller than the plenum depth and height. Doors shall open against system pressure.
- I. Corner seams and where applicable bottom seams shall be soldered watertight at least 12" up from bottom.
- J. Plenums shall have neoprene gaskets or other corrosion resistant material to make connections to louvers or to base curbs watertight.
- K. For elevated plenum, pitch floor down in direction of louver. Provide 2 inches half-coupling drain connection at floor of plenum unless noted otherwise. Pipe connection to nearest floor drain.

## **2.6 SINGLE WALL PLENUMS AND CONNECTIONS TO LOUVERS**

- A. General Fabrication Requirements: Plenums shall be constructed as an insulated single wall casing in accordance with SMACNA Duct Construction Manual, Chapter 9, Equipment and Casings. Insulation shall be applied to the room side of the plenum and shall have a minimum insulation value specified in Division 23 HVAC insulation Section.
- B. Minimum Wall Material: 18 gauge galvanized, solid sheet.
- C. Corner seams and where applicable bottom seams shall be soldered watertight at least 12 inches up from bottom.
- D. Plenums shall have neoprene gaskets or other corrosion resistant material to make connections to louvers or to base curbs watertight.
- E. For elevated plenum, pitch floor down in direction of louver. Provide 2 inches half-coupling drain connection at floor of plenum unless noted otherwise. Pipe connection to nearest floor drain.
- F. For plenums 36 inches deep and 80 inches high or larger, provide access 30 inches wide x 72 inches high access doors in accordance with SMACNA Duct Construction Manual, Chapter 9, Equipment and Casings. Provide continuous piano hinge. Latches shall be operable from both sides of door. For smaller plenums, provide double wall access door with dimensions 6 inches smaller than the plenum depth and height. Doors shall open against system pressure.

## **2.7 DUCT LINER**

- A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. CertainTeed Corporation.
    - b. Johns Manville; a Berkshire Hathaway company.
    - c. Knauf Insulation.
    - d. Owens Corning.
  - 2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

3. Water-Based Liner Adhesive: Comply with NFPA 90A and with ASTM C 916.
  - a. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Insulation Pins and Washers:
  1. Cupped-Head, Capacitor-arge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- (3.5-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
  2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized steel, aluminum or stainless steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
- C. Shop Application of Duct Liner: Comply with SMACNA Duct Construction Manual, Figure 7-11, "Flexible Duct Liner Installation".
  1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
  2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
  3. Butt transverse joints without gaps, and coat joint with adhesive.
  4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
  5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
  6. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.
  7. Secure transversely oriented liner edges facing the airstream with metal nosing that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
    - a. Fan discharges.
    - b. Intervals of lined duct preceding unlined duct.
  8. Terminate inner ducts with build-outs attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated build-outs (metal hat sections) or other build-out means are optional; when used, secure build-outs to duct walls with bolts, screws, rivets, or welds.

## 2.8 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
  1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
  2. Tape Width: 4 inches (102 mm).
  3. Sealant: Modified styrene acrylic.
  4. Water resistant.
  5. Mold and mildew resistant.
  6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
  7. Service: Indoor and outdoor.
  8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
  9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
  10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- C. Water-Based Joint and Seam Sealant For Duct Air Temperatures Above 0 deg F:
1. Application Method: Brush on.
  2. Solids Content: Minimum 65 percent.
  3. Shore A Hardness: Minimum 20.
  4. Water resistant.
  5. Mold and mildew resistant.
  6. VOC: Maximum 75 g/L (less water).
  7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
  8. Service: Indoor or outdoor.
  9. Service Temperature: 0 to plus 200 deg F (minus 17.8 to plus 93 deg C).
  10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
  11. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  12. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
  13. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
  14. Service: Indoor or outdoor.
  15. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- D. Solvent-Based Joint and Seam Sealant For Duct Air Temperatures Below 0 deg F (e.g. outside air ductwork in cold climates):
1. Application Method: Brush on.
  2. Base: Synthetic rubber resin.
  3. Solvent: Toluene and heptane.
  4. Solids Content: Minimum 60 percent.
  5. Shore A Hardness: Minimum 60.
  6. Water resistant.
  7. Mold and mildew resistant.
  8. Sealant shall have a VOC content of 420 g/L or less.
  9. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.
  10. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
  11. Service: Indoor or outdoor.
  12. Service Temperature: Minus 20 to plus 200 deg F (minus 28.9 to plus 93 deg C).
  13. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.
- E. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
  2. Type: S.
  3. Grade: NS.
  4. Class: 25.
  5. Use: O.
  6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- G. Round Duct Joint O-Ring Seals:
1. Seal shall provide maximum leakage class of 3 cfm/100 sf at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) static-pressure class, positive or negative.

2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.9 HANGERS AND SUPPORTS

- A. Hanger Rods for Non-corrosive Environments: Cadmium-plated steel rods and nuts.
- B. Strap and Rod Sizes: Comply with SMACNA Duct Construction Manual, Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- D. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- G. Trapeze and Riser Supports:
  1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
  2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
  3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

## 2.10 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers: Dampers shall be shop or factory fabricated.
  1. Shop Fabricated Volume Dampers:
    - a. Dampers shall meet the requirements of SMACNA Duct Construction Manual Section 7.1.
  2. Factory Fabricated Volume Dampers:
    - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
      - 1) American Warming and Ventilating; a Mestek Architectural Group company.
      - 2) Flexmaster U.S.A., Inc.
      - 3) Greenheck Fan Corporation.
      - 4) McGill AirFlow LLC.
      - 5) Nailor Industries Inc.
      - 6) Ruskin Company.
      - 7) Trox USA Inc.
      - 8) Vent Products Co., Inc.
  3. Provide dampers that meet the following requirements:
    - a. Standard leakage rating, with linkage outside airstream.
    - b. Minimum differential pressure rating: 1 inch water column.
    - c. Minimum velocity rating: 2000 fpm.
    - d. Suitable for horizontal or vertical applications.
    - e. Frames:
      - 1) Frame: Manufacturer standard shape, minimum 0.0396-inch (20 gage) thick, galvanized sheet steel or stainless steel. Material shall match connecting duct materials.
      - 2) Corners shall be mitered, welded or shall be provided with gusset reinforcements.

- 3) Flanges for attaching to walls or flanged ductwork. For other application provide flangeless frames for installing in ducts.
- f. Blades:
  - 1) Multiple or single blade.
  - 2) Opposed-blade design for multiple blade dampers.
  - 3) Stiffen damper blades for stability.
  - 4) Galvanized or stainless-steel, minimum 0.0635-inch (16 gage) thick. Material shall match connecting duct materials
- g. Blade Axles: Galvanized steel, plated steel or stainless steel.
- h. Bearings:
  - 1) Oil-impregnated bronze or oil-impregnated stainless-steel sleeve.
- i. Dampers in ducts with pressure classes of 3-inch w.g. (750 Pa) or less shall have axle length that matches full length of damper blades and bearings at both ends of operating shaft.
- j. Tie Bars and Brackets: Galvanized steel.
- k. Provide with locking quadrant arm and standoff bracket. For ductwork requiring Seal Class A, provide sealed end bearing and regulator arms assembly to prevent leakage through the shaft core.

## 2.11 FIRE DAMPERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
  1. American Warming and Ventilating; a Mestek Architectural Group company.
  2. Arrow United Industries.
  3. Greenheck Fan Corporation.
  4. Nailor Industries Inc.
  5. Pottorff.
  6. Prefco.
  7. Ruskin Company.
  8. Vent Products Co., Inc.
- B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class (differential pressure) and minimum 2000-fpm (10-m/s) velocity.
- D. Fire Rating: 1-1/2 hour rated damper for walls rated for less than 3 hours and 3 hour rated damper for walls with higher fire rating. Refer to architectural drawings for wall fire ratings.
- E. Frame: For duct mounted dampers provide curtain type with blades outside air stream or multiple opposed blade type with blades in air stream. For dampers located behind grilles curtain type dampers, blades inside airstream are acceptable. Fabricate with hat channel of galvanized steel or stainless steel to match duct material with thickness (gage) required by the damper U.L. listing.
  1. Curtain type fire dampers shall be Case 2 or 3 with blades out of airstream Type "B or C" as defined in SMACNA "Fire, Smoke and Radiation Damper Installation Guide for HVAC Systems – 5<sup>th</sup> Edition" pages 5.8, 5.11, and 7.2.
  2. Where duct dimensions require multiple damper sections, provide curtain type identified above with dampers arranged out of airstream (limited to two stacked dampers with blades on perimeter) or provide multiple opposed blade type dampers.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
  1. Minimum Thickness: Thickness (gage) required by the damper U.L. listing.
  2. Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame shall comply with sleeve requirements.



- G. Provide breakaway connections at all fire dampers. Seal all breakaway connections with manufacturer UL approved sealant to prevent air leakage.
- H. Mounting Orientation: Vertical and horizontal - refer to plans for orientation. Confirm orientation based on approved coordination drawings.
- I. Blades: Roll-formed, galvanized or stainless steel sheet steel to match duct construction in thickness required by damper U.L. listing. Blades shall be one of the following:
  - 1. Interlocking blade, or
  - 2. Constructed with full-length blade connectors matching blade material.
- J. Horizontal Dampers: Include blade lock and stainless-steel closure spring where required by manufacturer UL listing.
- K. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.

**2.12 SMOKE DAMPERS, COMBINATION FIRE-SMOKE DAMPERS, CORRIDOR (CEILING) DAMPERS**

- A. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
  - 1. American Warming and Ventilating; a Mestek Architectural Group company.
  - 2. Cesco Products; a division of MESTEK, Inc.
  - 3. Greenheck Fan Corporation.
  - 4. Nailor Industries Inc.
  - 5. Pottorff.
  - 6. Ruskin Company.
- B. General Requirements:
  - 1. Combination Fire-Smoke Damper Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
  - 2. Smoke Damper: rated and labeled according to UL 555S by an NRTL.
- C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 2000-fpm (10-m/s) velocity.
- D. Fire-Smoke Damper Fire Rating: 1-1/2 hour rated damper for walls rated for less than 3 hours and 3 hour rated damper for walls with higher fire rating. Refer to architectural drawings for wall fire ratings.
- E. Heat-Responsive Device: Resettable, 165 deg F (74 deg C) rated, fire-closure device or electric fuse link.
  - 1. Smoke Detector: provided by Division 28.
- F. Damper Actuators: Provide two-position action unless modulating type action is indicated otherwise on the drawings.
  - 1. Actuators shall be provided by and factory mounted by the damper manufacturer in accordance with the damper U.L Listing.
  - 2. Actuators shall be electric unless noted otherwise.
  - 3. Electrical Connection: 115 V, single phase, 60 Hz.
- G. Accessories:
  - 1. Auxiliary switches for position indication. Provide additional switches for signaling and fan control where indicated on drawings.
  - 2. Test and reset switches with red (closed) and green (open) LED indicator lights, remote mounted.

## 2.13 FLANGED BREAKAWAY CONNECTORS

- A. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
  - 1. Ductmate Industries, Inc.
  - 2. Hardcast, Inc.
  - 3. Nexus PDQ.
  - 4. Ward Industries; a brand of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.
- E. Seal all breakaway connections with manufacturer UL approved sealant to prevent air leakage.

## 2.14 SOUND ATTENUATORS (SILENCERS) FOR AIR DISTRIBUTION SYSTEMS

- A. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
  - 1. Price Industries
  - 2. Vibro-Acoustics.
  - 3. VAW Systems, LTD
- B. General:
  - 1. Factory fabricated.
  - 2. Media-filled silencers
    - a. Fire-Performance Characteristics: Adhesives, sealants, packing materials, and accessory materials shall have flame-spread index not exceeding 25 and smoke-developed index not exceeding 50 when tested according to ASTM E84.
  - 3. Packless silencers
    - a. Airstream surfaces: No sound absorptive materials of any kind shall be used in the silencers. The silencers shall attenuate air/gas transmitted noise solely by virtue of controlled impedance membranes and broadly tuned resonators.
- C. Shapes indicated on the drawings (e.g. linear, elbow, round).
- D. Outer Casing Material Shall Match Attached Ductwork:
  - 1. ASTM A653/A653M, G90 (Z275), galvanized sheet steel,
  - 2. 304L stainless steel.
- E. Inner Casing and Baffle Material Shall Match Outer Casing Material:
  - 1. ASTM A653/A653M, G90 (Z275) galvanized sheet metal, thickness and perforations as determined by the manufacturer to meet the specified performance.
  - 2. 304L stainless steel, thickness and perforations as determined by the manufacturer to meet the specified performance.
- F. Special Construction:
  - 1. Suitable for outdoor use where indicated on drawings.
- G. Connection Sizes: Match connecting ductwork unless otherwise indicated.
- H. Principal Sound-Absorbing Mechanism:
  - 1. Packless Silencers

- a. Controlled impedance membranes and broadly tuned resonators without absorptive media.
- 2. Media-filled Silencers
  - a. Film-lined type with fill material.
    - 1) Fill Material: Inert and vermin-proof fibrous material.
    - 2) Erosion Barrier: Polymer bag enclosing fill, and heat sealed before assembly.
    - 3) Lining: Mylar, Tedlar or Foil Lined meeting flame and smoke spread fire performance requirements.
- I. Fabricate silencers to form rigid units that will not pulsate, vibrate, rattle, or otherwise react to system pressure variations. Do not use mechanical fasteners for unit assemblies.
  - 1. Joints: Lock formed and sealed, continuously welded or flanged connections to match connected ductwork.
  - 2. Suspended Units: Factory-installed suspension hooks or lugs attached to frame in quantities and spaced to prevent deflection or distortion.
  - 3. Reinforcement: Cross or trapeze angles for rigid suspension.
- J. Accessories:
  - 1. Factory-installed end caps to prevent contamination during shipping.
- K. Source Quality Control: Performance shall be verified according to ASTM E477-13 verified in an NVLAP accredited laboratory.
  - 1. Selections shall be made based on published acoustic ratings, including dynamic insertion loss and self-generated-noise power levels with minimum airflow face velocity matching schedule. Performance data shall be provided with airflow in same direction as attenuation for supply ducts and in opposite direction of airflow for return or exhaust systems. Attenuation shall not be less than the scheduled performance in each octave band.
  - 2. Leak Test: Test units for airtightness at 200 percent of associated fan static pressure or 6-inch wg (1500-Pa) static pressure, whichever is greater.

## **2.15 SHORT RADIUS ELBOW SPLITTER VANES (FULL LENGTH SPLITTER VANES)**

- A. Provide short radius (full length splitter) vanes for elbows with a centerline radius less than 1.5 times the duct width in the plane of the elbow.
  - 1. Comply with SMACNA Duct Construction Manual; Chart 4-1 and Figure 4-2 (Type RE-3) elbows for spacing of vanes and figure 4-9 for construction of short radius full length splitter vanes. Refer to detail on drawings for quantity of full length splitter vanes required based on ratio of centerline to duct width dimensions.

## **2.16 REMOTE DAMPER OPERATORS**

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
  - 1. Pottorff.
  - 2. Ventfabrics, Inc.
  - 3. Young Regulator Company.
- B. Description: Cable system designed for remote manual damper adjustment.
- C. Cable: Sheathed stainless steel.
- D. Wall-Box Mounting: Recessed unless noted otherwise.
- E. Wall-Box Cover-Plate Material: Stainless steel.]

## 2.17 DUCT-MOUNTED ACCESS DOORS

- A. Duct Mounted Sandwich (Clamp) Type Access Doors – Ductwork and Plena Greater Than 2 inch Pressure Class.
1. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
    - a. Aire Technologies.
    - b. Ductmate Industries, Inc.
    - c. Nailor Industries Inc.
    - d. Ward Industries; a brand of Hart & Cooley, Inc.
  2. Duct-Mounted Access Doors: Factory fabricated, leak free insulated sandwich (clamp) type access door with minimum pressure rating equal to or greater than the attached ductwork. Material shall match connecting ductwork.
  3. Provide with manufacturer standard gasket, bolts and springs between inner and outer door.
  4. Provide wing nuts or molded knobs for low temperature applications and wing nuts for high temperature applications.
- B. SMACNA Access Doors – Ductwork and Plena 2” and Lower Pressure Class.
1. Fabricate access panels according to SMACNA Duct Construction Manual, Figures 7-2 (7-2M), "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
    - a. Door:
      - 1) Double wall, rectangular.
      - 2) Galvanized sheet metal with insulation fill and thickness for duct pressure class.
      - 3) Vision panel.
      - 4) Hinges and Latches: 1-by-1-inch (25mm-by-25-mm) butt or piano hinge and cam latches.
      - 5) Fabricate doors airtight and suitable for duct pressure class.
    - b. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
    - c. Number of Hinges and Locks:
      - 1) Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.
      - 2) Access Doors up to 18 Inches (460 mm) Square: Continuous hinge and two sash locks.
      - 3) Access Doors up to 24 by 48 Inches (600 by 1200 mm): Continuous hinge and two compression latches with outside and inside handles.
      - 4) Access Doors Larger than 24 by 48 Inches (600 by 1200 mm): Continuous hinge and two compression latches with outside and inside handles.

## 2.18 FLEXIBLE CONNECTORS

- A. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
1. Laboratory exhaust fan discharge and biosafety cabinet discharge collar connections:
    - a. Proco Style 501
    - b. Mercer
    - c. Pathway
    - d. Dynex
  2. For other non-grease exhaust systems and applications:
    - a. CL WARD & Family Inc.
    - b. Ductmate Industries, Inc.
    - c. Duro Dyne Inc.
    - d. Elgen Manufacturing.
    - e. Hardcast, Inc.
    - f. JP Lamborn Co.
    - g. Ventfabrics, Inc.
    - h. Ward Industries; a brand of Hart & Cooley, Inc.

- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip with the following minimum dimensions: 3-1/2 inches (89 mm) wide attached to two strips of 2-3/4 inch (70-mm-)wide, 0.028 inch (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric:
  - 1. Except for laboratory exhaust fan discharge connections, connections shall be glass fabric double coated with neoprene.
    - a. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
    - b. Minimum Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
    - c. Service Temperature: Minus 40 to plus 200 degrees F (Minus 40 to plus 93 degrees C).
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
  - 1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).
  - 2. Minimum Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
  - 3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

## 2.19 FLEXIBLE DUCTS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
  - 1. Buckley Associates, Inc.
  - 2. Flexmaster U.S.A., Inc.
  - 3. JP Lamborn Co.
  - 4. McGill AirFlow LLC.
  - 5. Thermaflex; a Flex-Tek Group company.
  - 6. Ward Industries; a brand of Hart & Cooley, Inc.
- B. Non-Insulated Flexible Duct
  - 1. Performance:
    - a. UL 181, Class 1.
    - b. Pressure Rating: Minimum 4-inch wg (1000 Pa) positive and 0.5-inch wg (125 Pa) negative.
    - c. Maximum Air Velocity: 4000 fpm (20 m/s).
    - d. Temperature Range: Minus 20 to plus 175 deg F (Minus 29 to plus 79 deg C).
- C. Insulated Flexible Ducts
  - 1. Performance:
    - a. UL 181, Class 1, fibrous-glass insulation, vapor-barrier film.
    - b. Pressure Rating: Minimum 4-inch wg (1000 Pa) positive and 0.5-inch wg (125 Pa) negative.
    - c. Maximum Air Velocity: 4000 fpm (20 m/s).
    - d. Temperature Range: Minus 20 to plus 175 deg F (Minus 29 to plus 79 deg C).
    - e. Insulation R-Value: Comply with ASHRAE/IES 90.1.
- D. Flexible Duct Connectors:
  - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.

## **2.20 DUCT ACCESSORY HARDWARE**

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot-tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## **2.21 DIFFUSERS, REGISTERS & GRILLES**

- A. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include the following or approved equivalent:
  - 1. Anemostat Products; a Mestek Company.
  - 2. Carnes Company.
  - 3. Hart & Cooley Inc.
  - 4. Kreuger.
  - 5. Metalaire, Inc.
  - 6. Nailor Industries Inc.
  - 7. Price Industries.
  - 8. Titus.
  - 9. Tuttle & Bailey.
- B. Provide diffusers, registers, and grilles for supply, return and exhaust outlets of size, type and, material of construction matching the basis of design devices scheduled on the drawings.
- C. Equipment shall be tested and rated according to ASHRAE Standard 70-2006 (RA 2011), "Method of Testing for Rating the Performance of Air Outlets and Inlets".
- D. Room air velocities shall be determined in accordance with ASHRAE Standard 113-2013.
- E. Equipment shall handle air quantities at operating velocities:
  - 1. With maximum diffusion within space supplied or exhausted.
  - 2. Without objectionable air movement as determined by Architect.
  - 3. With rated sound level not to exceed NC30.
- F. Supply, return and exhaust outlets shall have opposed blade volume dampers operable from front.
- G. Supply registers shall have two sets of directional control blades.
- H. Diffusers within same room or area shall be of same type and style to provide uniformity of appearance.
- I. Surface mount diffusers, registers and grilles shall be furnished with gaskets and installed with faces set level and plumb, tightly against mounting surface.
- J. Coordinate diffusers, registers and grilles with ceiling and wall construction. Refer to Architectural Drawings for exact lengths and for framing and mitering arrangements that may differ from those shown on Division 23 Drawings.
- K. General Construction and Performance Requirements
  - 1. Supply diffusers shall be specifically designed for variable-air-volume flows.
  - 2. Material: Steel, aluminum or stainless steel consistent with basis of design scheduled diffuser, register or grille.
  - 3. Finish: Steel and aluminum diffusers, registers and grilles shall have a baked enamel finish with color selected by Architect. Stainless steel diffusers and grilles shall have a brushed finish.

4. Mounting: Coordinate selections with ceiling grid indicated on the architectural drawings.
  5. Pattern: Provide fully adjustable or fixed pattern consistent with scheduled basis of design diffuser, register or grille.
  6. Dampers: Opposed blade or butterfly.
  7. Accessories:
    - a. Equalizing grid where run out branch to the device is less than 18 inches long.
    - b. Plaster ring for devices mounted in dry wall construction.
    - c. Safety chain for devices with a face area equal to or larger than 3 square feet.
- L. Supplemental Requirements for Continuous Linear Diffusers
1. Provide materials and accessories for a complete installation of linear and modular slot air diffusers. Installation shall include appurtenances to meet performance indicated. Provide plenums, hoods, blank-offs and sheet metal components including duct connections to the plenums.
  2. For ceiling mounted continuous linear slot and modular slot diffusers, diffusers shall integrate into the ceiling system. Where curved linear slot diffusers are indicated, they shall be stretch formed to the exact radii required. Rolled or segmented linear slot diffusers will not be accepted.
  3. Linear slot diffusers shall have the number of slots scheduled and shall be capable of being used for supply air, return air, exhaust air or any combination.
  4. Provide hanger wire support clips that are integral with the linear slot diffusers in lay in ceilings to allow diffusers to be supported from the building structure. For hard ceilings, provide clips integral with the linear slot diffusers to allow diffusers to be secured directly to the ceiling framing without need for hanger supports. Provide spline clips to secure joints and ceiling tees to the diffusers.
  5. Provide ends and corners. Ends shall be butt type, field installed, or mitered picture frame type factory installed. Corners shall be mitered one piece unit.
  6. Pattern controllers shall be one piece positioned between spring loaded spacers. Pattern controllers shall allow the airstream to be directed flat against the ceiling in either direction or downward as well as allowing throw reduction every two feet along the entire length of the linear slot diffusers. Airstream shall be maintained at the ceiling plane and shall not dump when volume is reduced.
  7. Material shall match the basis of design product specified. Spring steel retainers shall be used under the spacers to hold the slot diffusers assembly tightly together and allow the slot diffusers to be disassembled easily for field trimming.
  8. Flanges exposed to view shall be painted factory standard white. All other surfaces shall be painted flat black. Provide paint samples for approval prior to shipment.
  9. Slot diffusers shall be manufactured by the same manufacturer of the plenums and hoods.
  10. Plenums shall be minimum 24-gauge galvanized steel and lined inside with black matte fiberglass insulation with antimicrobial spray coating.
  11. Provide a friction type volume damper located in the entry collar of the supply air plenum, accessible for adjustment through the slot diffuser.
  12. Position pattern controllers in their normal operation positions before performing air testing and balancing.
  13. Slot diffusers shall be performance tested with air plenums as a composite assembly.
- M. High Induction Diffusers, Registers and Grilles.
1. Titus TDC diffuser with TRV "throw reducing vanes"

## **PART 3 - EXECUTION**

### **3.1 DUCT INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct

systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

- B. Install ducts and specified fittings in accordance with procedures outlined in SMACNA Duct Construction Manual unless otherwise indicated.
- C. Ductwork Fittings:
  - 1. Use only the following fittings, shown in Figures 4.2 through 4.9 and Chart 4.1 of the SMACNA Duct Construction Manual.
    - a. Rectangular Elbows - Figure 4.2
      - 1) Type RE-1
      - 2) Type RE-3. See also Chart 4-1 and Figure 4-9
      - 3) Type RE-5
      - 4) Type RE-6
      - 5) Type RE-8
    - b. Divided Flow Branches - Figure 4-5
      - 1) Type 1
      - 2) Type 3
      - 3) Type 4A (optional mitered elbow not acceptable)
      - 4) Type 4B (optional mitered elbow not acceptable)
    - c. Branch Connections - Figure 4-6
      - 1) 45 Degree Entry
      - 2) 45 Degree Lead In
      - 3) Conical
      - 4) Bellmouth
    - d. Offsets & Transitions - Figure 4-7
      - 1) Any type shown.
    - e. Obstructions
    - f. Figure A, B, C & E.
      - 1) Figure D only if mitered elbows with vanes are replaced with short radius elbows with full length splitter vanes.
- D. Install double wall ductwork in accordance with manufacturer instructions.]
- E. Install ducts in maximum practical lengths to minimize quantity of joints in the system.
- F. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- G. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- I. Install ducts with a clearance of 1 inch (25 mm) plus allowance for insulation thickness.
- J. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- K. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).
- L. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 for fire and smoke dampers.



- M. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

### **3.2 INSTALLATION OF EXPOSED DUCTWORK**

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

### **3.3 HANGER AND SUPPORT INSTALLATION**

- A. Provide hangers and supports in compliance with SMACNA Duct Construction Manual, Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. [Install concrete inserts before placing concrete.]
  - 2. [Install powder-actuated concrete fasteners after concrete is placed and completely cured.
    - a. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
    - b. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.]

### **3.4 INSTALLATION OF METAL DUCT ACCESSORIES**

- A. Install duct accessories according to applicable details in SMACNA Duct Construction Manual for metal ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel ductwork, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install backdraft and control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated. Refer drawings for applicable damper types.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
  - 1. Install steel volume dampers in steel ducts.
  - 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.

- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Installation of sound attenuators (silencers):
  - 1. Rigidly connect ducts to sound attenuators.
  - 2. Sound attenuator manufacturer basic installation instructions shall not be compromised to ensure pressure drops and self-generated sound power levels do exceed scheduled values. Install sound attenuators with baffles oriented in plane of turn when distance to nearest change in direction is less than attenuator manufacturer optimal distance.
  - 3. Duct sound attenuator supplier or qualified representative shall provide supervision to ensure correct installation of duct sound attenuators.
  - 4. Resiliently isolate sound attenuators from building construction at points of penetration of building structure with 0.75 inch minimum of 3 pound per cubic foot density fibrous glass. Seal penetration ends airtight with non-hardening caulk.
  - 5. Multiple attenuators grouped together in parallel within duct system shall be sealed airtight with the same sealant used on the attached ductwork.
- I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. On both sides of duct coils.
  - 2. Upstream from duct mounted filters.
  - 3. At outdoor-air intakes and mixed-air plenums.
  - 4. At drain pans and seals.
  - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
  - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
  - 7. At each change in direction and at maximum 50-foot (15-m) spacing.
  - 8. Upstream and downstream from splitter vanes.
  - 9. Upstream or downstream from sound attenuators (silencers).
  - 10. Control devices requiring inspection.
  - 11. Elsewhere as indicated.
  - 12. Install access doors with swing against duct static pressure.
  - 13. Minimum Access Door Sizes:
    - a. One-Hand or Inspection Access: 8 inches by 5 inches (200 by 125 mm).
    - b. Two-Hand Access: 12 inches by 6 inches (300 by 150 mm).
    - c. Head and Hand Access: 18 inches by 10 inches (460 by 250 mm).
    - d. Head and Shoulders Access: 21 inches by 14 inches (530 by 355 mm).
    - e. Body Access: 25 inches by 14 inches (635 by 355 mm).
    - f. Body Plus Ladder Access: 25 inches by 17 inches (635 by 430 mm).
    - g. Access doors for fire dampers shall be located so that the spring catch and fusible links are accessible when the damper is closed. Fire damper access doors shall be no smaller than 12 inches by 12 inches. Where duct size does not permit the minimum size access door, provide a minimum 12 inch long removable duct section to allow access for reset of fusible link. As duct size increases beyond 16 inches in any one direction, access door shall be no less than 2 inches smaller than the larger duct dimension by a minimum of 12 inches long. As the shorter dimension increases above 16 inches the length of the damper shall be no less than 2 inches smaller than the duct in each dimension but shall not exceed 18 inches x 16 inches. For dampers that are too large for an ordinary person's arms to reach from outside the duct to reset the damper and replace the fusible link, the minimum size for the access door shall be increased to 24 inches x 16 inches to allow the entrance of an individual.
- J. Label access doors according to Division 23 to indicate the purpose of access door.

- K. Install flexible connectors to connect ducts to equipment.
- L. For fans developing static pressures of 5 inches water column (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- M. Connect terminal units with fans to supply and return ducts with flexible connectors. Do not use flexible connectors to change directions.
- N. Connect diffusers or light troffer boots to ducts directly or with maximum 36-inch (900-mm) lengths of flexible duct clamped or strapped in place.
- O. Connect flexible ducts to metal ducts with ty-wrap tool or reusable stainless steel draw bands.
- P. Install duct test holes where required for testing and balancing purposes.
- Q. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop of fans.

### **3.5 INSTALLATION OF DIFFUSERS, REGISTERS AND GRILLES**

- A. Prior to installation, examine areas where diffusers, registers and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Install diffusers, registers and grilles level and plumb.
- C. Outlets and Inlets Locations: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- D. Install diffusers, registers and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

### **3.6 CONNECTIONS TO EQUIPMENT**

- A. Comply with SMACNA Duct Construction Manual for branch, outlet and inlet, and terminal unit connections.
- B. Make connection to motorized equipment with flexible connectors.

### **3.7 PAINTING**

- A. Paint interior of metal ducts that are visible through diffusers, registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09.

### 3.8 DOUBLE WALL PLENUMS

- A. Install double wall plenums and casings according to the manufacturer's requirements.
- B. Apply sealant to joints, connections, and mountings.
- C. Field-cut openings for pipe and conduit penetrations; insulate and seal according to SMACNA Duct Construction Manual.
- D. Support casings on floor or foundation system. Secure and seal to base.
- E. Support components rigidly with ties, braces, brackets and anchors of types that will maintain housing shape and prevent buckling.
- F. Align wall accurately at connections, with 1/8-inch misalignment tolerance and with smooth interior surfaces.
- G. Prepare and submit test and inspection reports.

### 3.9 AIR DISTRIBUTION SYSTEM CLEANliness

- A. Maintain ductwork in accordance with SMACNA "Duct Cleanliness for New Construction Guidelines." Maintain Advanced Cleanliness Level as defined in the guideline.
- B. Air Distribution System Cleanliness Verification and Testing:
  - 1. Visually inspect duct system to ensure that no visible contaminants are present.
  - 2. Test sections of metal duct system, chosen randomly by Architect, for cleanliness according to "Vacuum Test" in NADCA ACR 2013, "Assessment, Cleaning and Restoration of HVAC Systems."
    - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
  - 3. Air distribution system will be considered defective if it does not pass tests and inspections.
- C. Unless noted otherwise (e.g. existing ductwork), clean duct systems and components that do not pass visual inspection or random testing as follows:
  - 1. Use service openings for entry and inspection.
    - a. Create new openings and install access panels or doors appropriate for static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer.
    - b. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
    - c. Remove and reinstall ceiling to gain access during the cleaning process.
  - 2. Particulate Collection and Odor Control:
    - a. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
    - b. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.
  - 3. Clean the following components by removing surface contaminants and deposits:
    - a. Air outlets and inlets (registers, grilles, and diffusers).
    - b. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
    - c. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
    - d. Coils and related components.

- e. Return-air ducts, dampers, actuators, and splitter vanes except in ceiling plenums and mechanical equipment rooms.
  - f. Supply-air ducts, dampers, actuators, and splitter vanes.
  - g. Dedicated exhaust, ventilation and makeup air system components.
  - h. Plenums.
4. Mechanical Cleaning Methodology:
- a. Clean metal duct air distribution systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
  - b. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
  - c. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
  - d. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
  - e. Clean coils and coil drain pans according to NADCA ACR 2013. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
  - f. Provide drainage and cleanup for wash-down procedures.
  - g. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

### 3.10 START UP AND ADJUSTING

- A. Air Balance: Comply with requirements in other Sections of Division 23.
- B. After installation, adjust diffusers, registers and grilles to air patterns indicated or as directed, before the start of air balancing.

### 3.11 DUCT SEALING

- A. Duct Sealant and Leakage Fraction: Seal ducts to the following seal and leak classes. For purposes of this specification seal class identified shall be used only to define specific seams and joints to be sealed and applies to all duct pressure classes.
  - 1. Seal Class A as defined by ASHRAE 90.1: A ductwork sealing category that requires sealing all transverse joints, longitudinal seams, and duct wall penetrations. Duct wall penetrations are openings made by pipes, holes, conduit, tie rods, or wires. Longitudinal seams are joints oriented in the direction of airflow. Transverse joints are connections of two duct sections oriented perpendicular to airflow.
  - 2. Leakage factors specified are as recommended in the ASHRAE Systems and Equipment Handbook.

Duct Construction Class	Pressure	SMACNA Seal Class	Maximum Allowable Leakage Fraction***
10 inches water column (2500 Pa)	Pos. or Neg.	A	2 percent * 5 percent**
6 inches water column (1500 Pa)	Pos. or Neg.	A	2 percent * 5 percent**
4 inches water column (1000 Pa)	Pos. or Neg.	A	2 percent * 5 percent**
3 inches water column (750 Pa)	Pos. or Neg.	A	2 percent * 5 percent**

Duct Construction Class	Pressure	SMACNA Seal Class	Maximum Allowable Leakage Fraction***
2 inches water column (500 Pa)	Pos. or Neg.	A	2 percent * 5 percent**
<p>*2 percent of system air flow rate for return and supply ducts outdoors and exhaust ducts indoors.  **5 percent of system air flow rate for all other duct.  ***See "FIELD QUALITY CONTROL" Article, Sub-Articles "Duct System Leakage Tests" and "Leakage Factor/Leakage Fraction" in this Section.</p>			

### 3.12 DUCT SCHEDULE

- A. Duct Construction: Fabricate ducts with galvanized sheet steel except as otherwise indicated. Duct pressure classification criteria: Duct system pressure classification shall be determined based on the following criteria:

General Duct Service	Duct Construction Minimum Pressure Classification Criteria  Fan Discharge = Positive Return Inlet = Negative Exhaust Inlet = Negative	Duct Material of Construction
VAV air handling unit supply ductwork from AHU to terminal box inlet	125 percent of unit external static pressure shown in the equipment schedules – minimum 4 inches water column	G90 galvanized
VAV return ductwork from terminal box outlet to return fan or where system has no separate return fan and all ductwork on return fan discharge	125 percent of return fan external static pressures shown in the equipment schedules – minimum 2 inches water column	G90 galvanized
Non-laboratory VAV exhaust ductwork from terminal box outlet to exhaust fan inlet and all ductwork on exhaust fan discharge	125 percent of exhaust fan external static pressure shown in the equipment schedules – minimum 2 inches water column.	G90 galvanized
Constant volume air handling unit supply ductwork (systems with no terminal boxes)	125 percent of supply fan external static pressure shown in equipment schedules – minimum 2 inches water column	G90 galvanized
Constant volume return ductwork (systems with no terminal boxes) and all ductwork on return fan discharge	125 percent of return fan external static pressure shown in equipment schedules and when system has no separate return fan – minimum 2 inches water column	G90 galvanized
Non-laboratory constant volume exhaust ductwork (systems with no terminal boxes) and all ductwork on exhaust fan discharge	125 percent of exhaust fan external static pressure shown in equipment schedules – minimum 2 inches water column.	G90 galvanized
Ductwork downstream of supply air terminal boxes and air valves and upstream of return and non-laboratory exhaust terminal boxes and air valves.	2 inches water column	G90 galvanized (except where noted otherwise)
All ducts connected to local terminal units including fan coil units, furnaces and heat pumps.	2 inches water column	G90 galvanized

General Duct Service	Duct Construction Minimum Pressure Classification Criteria  Fan Discharge = Positive Return Inlet = Negative Exhaust Inlet = Negative	Duct Material of Construction
Ductwork containing unconditioned air from outside intake location to equipment being served	100 percent of air handling unit or fan external static pressure, minimum 2 inches water column	G90 galvanized
Supply, return and exhaust ducts connected to equipment not listed or otherwise identified in this Section	4 inches water column	G90 galvanized
Toilet room and shower (wet exhaust) – slope 1 percent back to room	125 percent of fan external static pressure or 2 inches water column whichever is greater, air and water tight.	304L stainless steel or aluminum for first 20 feet from the space then G90 galvanized for remainder of the system
Ducts immediately before and after duct mounted humidifiers – slope 1 percent back to drain	Match duct pressure class, air and water tight.	304L stainless steel or aluminum
<p>**Construct at the next higher SMACNA pressure class when calculation results in a fractional condition. (e.g. where fan external static is 4 inches water column and test pressure is defined as 110 percent of the fans external static pressure, <math>1.1 \times 4 = 4.4</math>; duct shall be constructed at 6 inches water column pressure class).</p> <p>All ductwork exposed in occupied spaces shall be considered finished material and shall be cleaned of all contractor markings. Provide Number 4 finish for all exposed stainless steel ductwork. Concealed stainless steel ductwork shall be 2B finish.</p>		

B. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. Stainless-Steel Ducts:
  - a. Exposed to Airstream: Match duct material.
  - b. Not Exposed to Airstream: Galvanized.
3. Aluminum Ducts: Aluminum.

C. Liner:

1. Provide the following liner material:
  - a. Supply Air Ducts: Fibrous glass, Type I.
  - b. Return Air Ducts: Fibrous glass, Type I.
  - c. Transfer Ducts: Fibrous glass, Type I or Natural fiber.
2. Thickness of liner shall meet the following requirements:
  - a. For supply return and exhaust ducts comply with Division 23 requirements for duct insulation thicknesses identified by climate zone. For transfer ducts: 1 inch (25 mm).
  - b. For acoustical duct lining provide the following thicknesses:
    - 1) Supply Air Ducts: 1 inch (25 mm) thick.
    - 2) Return Air Ducts: 1 inch (25 mm) thick.
    - 3) Transfer Ducts: 1 inch (25 mm) thick.

D. Double-Wall Duct Interstitial Insulation:

1. For supply return and exhaust ducts comply with Division 23 requirements for duct insulation thicknesses identified by climate zone.

E. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA Duct Construction Manual, Figure 4-2, "Rectangular Elbows."
  - a. Velocity 1000 fpm (5 m/s) or Lower:

- 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      - 2) Mitered Type RE 4 without vanes.
    - b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s):
      - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      - 1) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
    - c. Velocity 1500 fpm (7.6 m/s) or Higher:
      - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
  - 2. Round Duct: Comply with SMACNA Duct Construction Manual, Figure 3-4, "Round Duct Elbows."
    - a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA Duct Construction Manual, Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      - 1) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      - 2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      - 3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
      - 4) Radius-to Diameter Ratio: 1.5.
    - b. Round Elbows, 12 Inches (305 mm) and Smaller in Diameter: Stamped or pleated.
    - c. Round Elbows, 14 Inches (356 mm) and Larger in Diameter: Standing seam for non-welded ductwork. Provide welded elbows where welded ductwork is provided.
- F. Branch Configuration:
- 1. Rectangular Duct: Comply with SMACNA Duct Construction Manual, Figure 4-6, "Branch Connections," except straight taps shall not be used.
    - a. Rectangular Main to Rectangular Branch: 45-degree entry.
    - b. Rectangular Main to Round Branch: conical or bell-mouth only
  - 2. Round and Flat Oval: Comply with SMACNA Duct Construction Manual, Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted only in connections to existing duct.
    - a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
    - b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap.
    - c. Velocity 1500 fpm (7.6 m/s) or Higher: 45-degree lateral.

### 3.13 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Operate dampers to verify full range of movement.
  - 2. Inspect locations of access doors and verify that purpose of access door can be performed.
  - 3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
  - 4. Inspect splitter vanes for proper and secure installation.
  - 5. Operate remote damper operators to verify full range of movement of operator and damper.
- B. Duct System Leakage Tests:
  - 1. Unless otherwise noted in this section, leakage test procedures shall comply with Sub-Chapter 4.1 of the 2012 SMACNA Leak Test Manual, except Sections 2, 3, 7 (Section 7.a, 7.b, and 7.c are applicable only as referenced in the Article "Leakage Factor/Leakage Fraction" in this section) and 10.m (smoke tests shall not be conducted without written consent of the Architect)
  - 2. Leakage test apparatus shall comply with Chapter 6 of the SMACNA Leak Test Manual. Flow measuring equipment shall have a calibrated accuracy of plus or minus 3 percent of



- the maximum allowable air flow leakage rate of the duct section being tested. Calibration certificates, showing acceptable instrument accuracy and dated within 90 days of leakage tests, of all instrumentation (flow, temperature, pressure) shall be submitted with test reports
3. Unless otherwise noted, allowable system leakage shall be expressed as a fraction (percentage) of the total system flow as recommended in Chapter 19 of the ASHRAE Systems Handbook, article "Leakage Testing" beginning on page 19.3.
    - a. All outdoor supply and return ductwork shall have a leakage fraction less than or equal to 2 percent of the system air flow.
    - b. All indoor exhaust ductwork shall have a leakage fraction less than or equal to 2 percent of the system air flow.
    - c. All other ductwork shall have a leakage fraction less than or equal to 5 percent of the system air flow.
  4. Leakage tests shall be conducted at the pressure classification of the ductwork being tested. Do not exceed the installed duct pressure class rating.
  5. Submit a test report for each test. Reports shall comply with SMACNA Leak Test Manual, Sub-Chapters 7.1, 7.2 (excepting the reference to Table 5-1; Leakage Class and Seal Class shall be as indicated in the Articles of this Section), 7.3 (except Figure 5-1 or Appendix E shall not be used to determine leakage factor; leakage factor shall be calculated by the Contractor. Calculations shall be submitted to the Architect for review prior to conducting tests).
  6. See Article "Leakage Factor/Leakage Fraction" in this Section for calculation methodology.
  7. Duct leakage testing shall be performed with takeoffs, dampers (fire, smoke, control, combination fire/smoke manual volume control, etc.) duct mounted coils, and access doors installed.
  8. DUCT LEAKAGE TESTS SHALL NOT INCLUDE THE LEAKAGE OF AIR HANDLERS OR TERMINAL EQUIPMENT (E.G. VAV BOXES, AIR VALVES, FAN COIL UNITS, HEAT PUMPS). PROVIDE NECESSARY ARRANGEMENTS SO THESE DEVICES ARE ISOLATED FROM THE DUCT SECTIONS UNDER TEST.
  9. AIR HANDLERS, AND TERMINAL EQUIPMENT SHALL BE TESTED SEPARATELY, THEIR LEAKAGE SHALL BE INCLUDED IN THE OVERALL SYSTEM LEAKAGE. THE TOTAL SYSTEM (E.G. DUCT, AHU, DAMPERS, ACCESS DOORS, DUCT COILS) LEAKAGE SHALL NOT EXCEED 5 PERCENT OF THE TOTAL AIRFLOW OF THE SYSTEM GENERATED AT THE FAN (E.G. AHU).
  10. Division 23 section "TESTING, ADJUSTING, AND BALANCING FOR HVAC" FOR ADDITIONAL REQUIREMENTS.
  11. Leak test the following systems:
    - a. 100 percent of exterior ductwork regardless of pressure class.
    - b. 100 percent of interior ductwork with a pressure class 3 inches water column or higher.
    - c. All other ductwork: Test representative duct sections, selected by Architect from sections installed, totaling no less than 25 percent of total installed duct area.
  12. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
  13. Test for leaks before applying external insulation.
  14. Give seven day advance notice for testing to the Architect.
    - a. Notification regarding testing of Smoke Management systems shall be directed to the Owner, Architect and Special Inspector for Smoke Control systems.
- C. Leakage Factor/Leakage Fraction
1. Conduct tests at static pressures equal to maximum design pressure class of the system or section being tested. Do not pressurize systems above maximum design pressure class.
  2. For each fan system (fan system includes air handling unit fans) with ductwork required to be leak tested, the contractor shall determine the normalized air flow rate per square foot of duct surface area ( $Q_{fn}$ ) based on the ductwork shop drawings and the approved fan (AHU, etc) shop drawings.
  3. Contractor shall determine the duct surface area for each main, branch main branch and sub branch of duct connected to each fan system with ductwork required to be leak tested for each change in designed air flow carried in the duct.

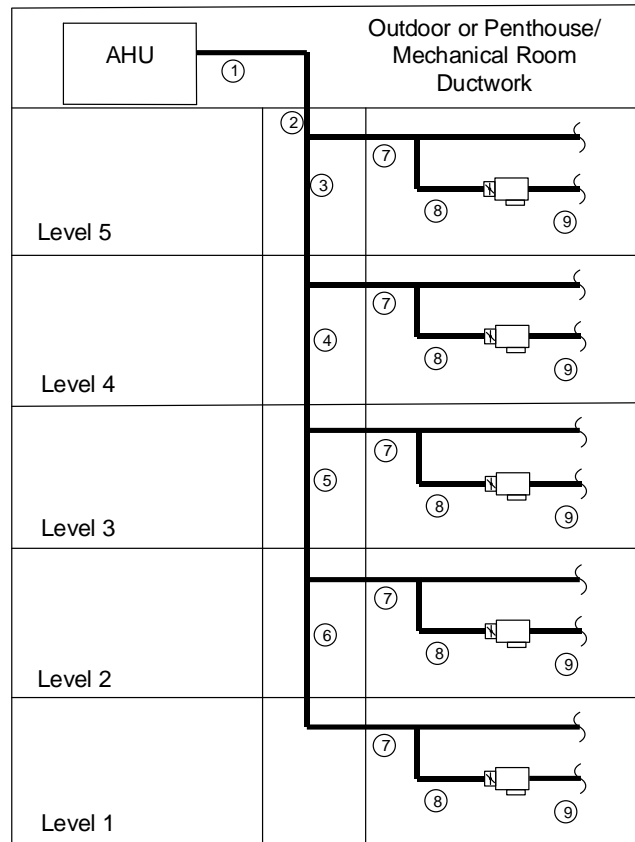
4. Leakage class (Cl) can be determined in accordance with ASHRAE/IES 90.1 by using the leakage fraction (Qlf), translated into a decimal, specified duct pressure class (Cp) and system air flow rate normalized per square foot of system duct surface area (Qfn) as follows:
  - 1)  $Cl = (Qlf * Qfn) / (Cp ^ 0.65)$
  - 2) To comply with ASHRAE/IES 90.1 Article 6.4.4.2.2, leakage class (Cl) shall be no greater than 4. When calculating leakage class, contractor shall reduce the leakage fraction, Qlf, as necessary to ensure leakage class does not exceed 4. See calculation example in the Article below.
5. For those systems wherein leakage testing will be conducted in sub-sections of the overall duct system, comply with the recommended procedures for calculating the allowable leakage fraction in a test sub-section described in Chapter 19 of the ASHRAE Systems Handbook Article "Calculating Test Section Allowable Leakage" beginning on page 19.4
6. Should testing reveal greater than the allowable leakage, inspect, re-seal and re-test as necessary and as described in Sections 7.a, 7.b, and 7.c of Sub-Paragraph 4.1 of the SMACNA Leak Test Manual (excepting that smoke tests shall not be conducted without express written consent of the Architect) to attain a measured air flow leakage from the test section equal to or less than the allowable air flow leakage from the test section.
7. For an example of the preceding paragraphs, refer to the Article "Leakage Test Example Calculations" in this Section.

### **3.14 ASHRAE SYSTEMS HANDBOOK COMPLIANT DUCT LEAKAGE ALLOWANCE SAMPLE CALCULATION**

#### **A. Example System Description and Diagram**

1. The supply side of a penthouse air handling unit designed to produce 100,000 CFM with an external static pressure of 4.5 inches water column is connected to a 6 inches water column pressure class duct riser system, serving five stories of office space. Each story will be supplied 20,000 CFM through a 4 inches water column pressure class branch main duct routed on the office floor and connected to 25 VAV terminal units. Downstream of the VAV terminal will be 2 inches water column pressure class duct routed to ceiling diffusers. The penetrations through the shaft on each floor will be protected by a combination smoke/fire damper with associated access doors, the branch connections will have manual volume dampers for balancing; VAV boxes will have duct mounted reheat coils.
  - a. Section 1: The surface area of the supply duct work in the penthouse is measured to be 750 square feet between the AHU discharge and the riser shaft and carries 100,000 CFM
  - b. Section 2 The surface area of the supply riser between the shaft entrance and the first take-off connection is 270 square feet and carries 100,000 CFM.
  - c. Section 3 – 6: The surface area between each subsequent take-off on the next four floors is 360 square feet between levels 5 and 4 (80,000 CFM); 325 square feet between level 4 and 3 (60,000 CFM); 265 square feet between levels 3 and 2 (40,000 CFM) and 200 square feet between levels 2 and 1 (20,000 CFM).
  - d. Section 7 – 8: The surface area of the branch main duct, including access doors, fire/smoke dampers and manual volume dampers, on each floor is 3,500 square feet, each VAV terminal has a 40 square foot surface area inlet connection (800 CFM).
  - e. Section 9: Downstream of each VAV box there is 150 square feet of surface area, including manual volume dampers, access doors and reheat coils, of distribution duct to 4 diffusers.

#### **B. Duct Leakage Test Example Diagram**



C. Calculations for 6 inches water column pressure class in the example. Contractor to perform calculations for all pressure classes and duct sections to be tested.

1. The total surface area of the duct is:
  - a.  $750$  (duct in penthouse) +  $270$  (duct between penthouse and level 5) +  $360$  (duct between L5 and L4) +  $325$  (duct between L4 and L3) +  $265$  (duct between L3 and L2) +  $200$  (duct between L2 and L1) +  $3500 \times 5$  (total branch main duct on all floors) +  $25 \times 5 \times 40$  (total VAV inlet branch connections) +  $25 \times 5 \times 150$  (total duct downstream of VAV) =  $43,420$  square feet.
2. Determine the normalized air flow of each section of duct (example continues for the 6 inches water column pressure class duct only, contractor to continue for all duct and pressures classes required to be leakage tested).
  - a. Penthouse duct;  $Q_{fn} = 100,000 / 750 = 133.33$  CFM/SF
  - b. Riser between PH and Level 5:  $Q_{fn} = 100,000 / 270 = 370.37$  CFM/SF
  - c. Riser between L5 and L4 :  $Q_{fn} = 80,000 / 360 = 222.22$  CFM/SF
  - d. Riser between L4 and L3;  $Q_{fn} = 60,000 / 325 = 184.61$  CFM/SF
  - e. Riser between L3 and L2:  $Q_{fn} = 40,000 / 265 = 150.94$  CFM/SF
  - f. Riser between L2 and L1:  $Q_{fn} = 20,000 / 200 = 100$  CFM/SF
3. Determine the leakage class each section of duct (example continues for the 6 inches water column pressure class duct only, contractor to continue for all duct and pressure classes required to be leakage tested).  $CI = Q_{fl} \times Q_{fn} / (C_p \wedge 0.65)$ .  $Q_{fl}$  shall be set to allowable leakage fraction (0.02 for outdoor/mechanical room ductwork. 0.02 for all exhaust ductwork and 0.05 for all other ductwork). If calculations result in a leakage class greater than 4, reduce the allowable leakage fraction  $Q_{fl}$  for that section to attain  $CI = 4$  or less. The adjusted value of  $Q_{fl}$  for that section shall be used in subsequent calculations to determine allowable leakage from the affected duct section.
  - a. Penthouse duct:  $CI = .02 \times 133.33 / (6 \wedge 0.65) = .83$
  - b. Riser between PH and Level 5:  $CI = .05 \times 370.37 / (6 \wedge .065) = 5.77$
  - c. Riser between L5 and L4 :  $CI = .05 \times 222.22 / (6 \wedge .065) = 3.46$
  - d. Riser between L4 and L3:  $CI = .05 \times 184.61 / (6 \wedge .065) = 2.88$
  - e. Riser between L3 and L2:  $CI = .05 \times 150.94 / (6 \wedge .065) = 2.35$

- f. Riser between L2 and L1:  $CI = .05 * 100 / (6 \wedge .065) = 1.56$
4. Determine the duct section area to total duct area ratio for each section of duct (example continues for the 6 inches water column pressure class duct only, contractor to continue for all duct and pressure classes required to be leakage tested).
  - a. Penthouse duct:  $\text{Section Area} / \text{Total Area} = 750 / 43,420 = 0.017$
  - b. Riser between PH and Level 5:  $270 / 43,420 = 0.006$
  - c. Riser between L5 and L4 :  $360 / 43,420 = 0.0083$
  - d. Riser between L4 and L3:  $325 / 43,420 = 0.0075$
  - e. Riser between L3 and L2:  $265 / 43,420 = 0.0061$
  - f. Riser between L2 and L1:  $200 / 43,420 = 0.0046$
5. Determine the allowable leakage per section of duct (example continues for the 6 inches water column pressure class duct only, contractor to continue for all duct and pressure classes required to be leakage tested). Allowable leakage = (Section to total area ratio) \* (Section air flow rate) \* (Section Leakage Fraction, Qlf, adjusted if necessary as described above)
  - a. Penthouse duct:  $\text{Allowable leakage} = 0.017 * 100,000 * .02 = 34 \text{ CFM}$
  - b. Riser between PH and Level 5:  $0.006 * 100,000 * .05 = 30 \text{ CFM}$
  - c. Riser between L5 and L4 :  $0.0083 * 80,000 * .05 = 33.2 \text{ CFM}$
  - d. Riser between L4 and L3:  $0.0075 * 60,000 * .05 = 22.5 \text{ CFM}$
  - e. Riser between L3 and L2:  $0.0061 * 40,000 * .05 = 12.2 \text{ CFM}$
  - f. Riser between L2 and L1:  $0.0046 * 20,000 * .05 = 4.6 \text{ CFM}$
6. The total allowable leakage in the duct system is the sum of the allowable leakage from each section of duct. For this example, the allowable leakage in the 6 inches water column pressure class duct sections is 136.5 CFM. Contractor shall continue these calculations for all pressure-classes to be tested to get a resulting total leakage allowed from the duct system.

D. Total System Leakage

1. The calculations above are for duct and accessories testing only and do not include leakage from air handlers or terminal equipment (see the Article "Duct System Leakage Tests" in the "Field Quality Control" Article) which are tested separately or leakage is published by the manufacturer and are considered "fixed" leakages.
2. The total system leakage, including "fixed" leakage, shall not exceed 5 percent of the total air flow for the fan (AHU, etc.) system being tested. If calculations of allowable duct leakage indicate a total system leakage, including "fixed" leakage values, exceeds 5 percent of the total fan (AHU, etc.) system flow; the leakage fraction (Qlf) of some or all of ductwork shall be reduced and the calculations repeated until total calculated leakage is less than or equal to 5 percent of the fan (AHU, etc.) system, total flow rate.
3. "Fixed" leakages may be determined by the manufacturer or field tested at the design pressure class. If the manufacturers' data are to be utilized, the leakage rate published by the manufacturers shall be adjusted to the design pressure class and calculated leakage class of the ductwork in which the item is installed.
  - a. For example, the AHU described above has been determined by the manufacturer to leak 1 percent of the total air flow at 4 inches water column. As the AHU is installed in 6 inches water column pressure class duct, the "fixed" leakage rate for the AHU shall be calculated as follows:
    - 1)  $\text{AHU "fixed" leakage} = \text{Manufacturers stated leakage rate} * \text{AHU design flow rate} * (\text{design pressure class} / \text{manufacturer's test pressure class}) \wedge .65 = 0.01 * 100,000 * (6/4) \wedge .65 = 1301.55 \text{ CFM}$
    - 1) In this example, 1.3 percent of the total system allowable leakage is allotted to the AHU; meaning either the duct construction (plus other "fixed" leakages) must result in no more than 3.7 percent of the total system flow rate in leaks or the manufacturer must be consulted to reduce the AHU leakage.

**END OF SECTION**



## **SECTION 23 34 16 - CENTRIFUGAL HVAC FANS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes: For each product.
  - 1. Airfoil centrifugal fans.
  - 2. Backward-inclined centrifugal fans.
  - 3. Forward-curved centrifugal fans.
  - 4. Plenum fans.
  - 5. Plug fans.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data:
  - 1. Include rated capacities, furnished specialties, and accessories for each fan.
  - 2. Certified fan performance curves with system operating conditions indicated.
  - 3. Certified fan sound-power ratings.
  - 4. Motor ratings and electrical characteristics, plus motor and electrical accessories.
  - 5. Material thickness and finishes, including color charts.
  - 6. Dampers, including housings, linkages, and operators.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
  - 4. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
  - 5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.
- B. Field quality-control reports.

## **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

## **1.6 MAINTENANCE MATERIAL SUBMITTALS**

- A. Belts: One set(s) for each belt-driven unit.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. AMCA Compliance:
  - 1. Comply with AMCA performance requirements and bear the AMCA-Certified Ratings Seal.
  - 2. Operating Limits: Classify according to AMCA 99.
- B. 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.

### **2.2 AIRFOIL CENTRIFUGAL FANS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
  - 1. Greenheck.
  - 2. Acme Engineering & Mfg. Corp.
  - 3. Aerovent; a Twin City Fan company.
  - 4. Central Blower Company.
  - 5. Chicago Blower Corporation.
  - 6. Cincinnati Fan.
  - 7. CML Northern Blower Inc.
  - 8. Howden Buffalo Inc.
  - 9. Loren Cook Company.
  - 10. New York Blower Company (The).
- B. Description:
  - 1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
  - 2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
  - 3. Factory-installed and -wired disconnect switch.
- C. Housings:
  - 1. Formed panels to make curved-scroll housings with shaped cutoff.
  - 2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
  - 3. Horizontally split, bolted-flange housing.
  - 4. Spun inlet cone with flange.
  - 5. Outlet flange.
- D. Airfoil Wheels:
  - 1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange.
  - 2. Heavy backplate.
  - 3. Hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate.
  - 4. Cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

- E. Shafts:
  1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
  2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
  3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
  
- F. Grease-Lubricated Shaft Bearings:
  1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
  2. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
  3. Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.
  
- G. Belt Drives:
  1. Factory mounted, with adjustable alignment and belt tensioning.
  2. Service Factor Based on Fan Motor Size: 1.5.
  3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
  4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
  5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
  6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or approved equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
  7. Motor Mount: Adjustable for belt tensioning.
  
- H. Accessories:
  1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
  2. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
  3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
  4. Inlet Screens: Grid screen of same material as housing.
  5. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
  6. Spark-Resistant Construction: AMCA 99.
  7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
  8. Weather Cover for outdoor units: Enameled-steel sheet with ventilation slots, bolted to housing.

### **2.3 BACKWARD-INCLINED CENTRIFUGAL FANS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
  1. Greenheck.
  2. Acme Engineering & Mfg. Corp.
  3. Aerovent; a Twin City Fan company.
  4. Central Blower Company.
  5. Chicago Blower Corporation.
  6. Cincinnati Fan.
  7. CML Northern Blower Inc.
  8. Howden Buffalo Inc.
  9. Loren Cook Company.
  10. New York Blower Company (The).



- B. Description:
1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
  2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
  3. Factory-installed and -wired disconnect switch.
- C. Housings:
1. Formed panels to make curved-scroll housings with shaped cutoff.
  2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
  3. Horizontally split, bolted-flange housing.
  4. Spun inlet cone with flange.
  5. Outlet flange.
- D. Backward-Inclined Wheels:
1. Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades, and fastened to shaft with set screws.
  2. Welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate.
- E. Shafts:
1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
  2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
  3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- F. Grease-Lubricated Shaft Bearings:
1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
  2. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
  3. Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.
- G. Belt Drives:
1. Factory mounted, with adjustable alignment and belt tensioning.
  2. Service Factor Based on Fan Motor Size: 1.5.
  3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
  4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
  5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
  6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or approved equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
  7. Motor Mount: Adjustable for belt tensioning.
- H. Accessories:
1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
  2. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
  3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
  4. Inlet Screens: Grid screen of same material as housing.
  5. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
  6. Spark-Resistant Construction: AMCA 99.
  7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.

8. Weather Cover for Outdoor Units: Enameled-steel sheet with ventilation slots, bolted to housing.

## 2.4 FORWARD-CURVED CENTRIFUGAL FANS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
  1. Greenheck.
  2. Acme Engineering & Mfg. Corp.
  3. Aerovent; a Twin City Fan company.
  4. Central Blower Company.
  5. Chicago Blower Corporation.
  6. Cincinnati Fan.
  7. CML Northern Blower Inc.
  8. Howden Buffalo Inc.
  9. Loren Cook Company.
  10. New York Blower Company (The).
- B. Description:
  1. Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor, drive assembly, and support structure.
  2. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations.
  3. Factory-installed and -wired disconnect switch.
- C. Housings:
  1. Formed panels to make curved-scroll housings with shaped cutoff.
  2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
  3. Horizontally split, bolted-flange housing.
  4. Spun inlet cone with flange.
  5. Outlet flange.
- D. Forward-Curved Wheels:
  1. Black-enameled or galvanized-steel construction with inlet flange, backplate, shallow blades with inlet and tip curved forward in direction of airflow.
  2. Mechanically secured to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.
- E. Shafts:
  1. Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with adjustable alignment and belt tensioning.
  2. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
  3. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
- F. Grease-Lubricated Shaft Bearings:
  1. Self-aligning, pillow-block-type, ball or roller bearings with adapter mount and two-piece, cast-iron housing.
  2. Ball-Bearing Rating Life: ABMA 9, L10 at 120,000 hours.
  3. Roller-Bearing Rating Life: ABMA 11, L10 at 120,000 hours.
- G. Belt Drives:
  1. Factory mounted, with adjustable alignment and belt tensioning.
  2. Service Factor Based on Fan Motor Size: 1.5.
  3. Fan Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.

4. Motor Pulleys: Adjustable pitch for use with motors through 5 hp; fixed pitch for use with larger motors. Select pulley so pitch adjustment is at the middle of adjustment range at fan design conditions.
  5. Belts: Oil resistant, nonsparking, and nonstatic; matched sets for multiple belt drives.
  6. Belt Guards: Fabricate to comply with OSHA and SMACNA requirements of diamond-mesh wire screen welded to steel angle frame or approved equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation. Include provisions for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
  7. Motor Mount: Adjustable for belt tensioning.
- H. Accessories:
1. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
  2. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
  3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
  4. Inlet Screens: Grid screen of same material as housing.
  5. Shaft Cooler: Metal disk between bearings and fan wheel, designed to dissipate heat from shaft.
  6. Spark-Resistant Construction: AMCA 99.
  7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
  8. Weather Cove for outdoor units: Enameled-steel sheet with ventilation slots, bolted to housing.

## **2.5 MOTORS**

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23, Common Motor Requirements for HVAC Equipment.

## **2.6 SOURCE QUALITY CONTROL**

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

## **2.7 MOTORS**

- A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23, Common Motor Requirements for HVAC Equipment.

## **2.8 SOURCE QUALITY CONTROL**

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210/ASHRAE 51, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating."

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install centrifugal fans level and plumb.
- B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.
- C. Lift and support units with manufacturer's designated lifting or supporting points.
- D. Equipment Mounting: Comply with requirements for vibration isolation devices specified in Division 23, Vibration and Controls for HVAC Piping and Equipment.
- E. Equipment Mounting: Comply with requirements for vibration isolation devices specified in Division 23, Vibration and Controls for HVAC Piping and Equipment.
- F. Curb Support: Install roof curb on roof structure, level and secure, according to "The NRCA Roofing and Waterproofing Manual," Low-Slope Membrane Roofing Construction Details Section, Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install and secure centrifugal fans on curbs, and coordinate roof penetrations and flashing with roof construction. Secure units to curb support with anchor bolts.
- G. Install units with clearances for service and maintenance.
- H. Label fans according to requirements specified in Division 23, Identification for HVAC Piping and Equipment.

### **3.2 CONNECTIONS**

- A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23, Air Duct Accessories.
- B. Install ducts adjacent to fans to allow service and maintenance.

### **3.3 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections:
  - 1. Verify that shipping, blocking, and bracing are removed.
  - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  - 3. Verify that cleaning and adjusting are complete.
  - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  - 5. Adjust belt tension.
  - 6. Adjust damper linkages for proper damper operation.
  - 7. Verify lubrication for bearings and other moving parts.

8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
  9. See Division 23, Testing, Adjusting, and Balancing For HVAC for testing, adjusting, and balancing procedures.
  10. Remove and replace malfunctioning units and retest as specified above.
- D. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

### **3.4 DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans.

### **END OF SECTION**

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## **SECTION 23 36 00 - AIR TERMINAL UNITS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Shutoff, single-duct air terminal units.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of the following products, including rated capacities, furnished specialties, sound-power ratings, and accessories.
  - 1. Air terminal units.
  - 2. Liners and adhesives.
  - 3. Sealants and gaskets.
- B. Shop Drawings: For air terminal units. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring Diagrams: For power, signal, and control wiring.
  - 3. Hangers and supports, including methods for duct and building attachment and vibration isolation.
- C. Delegated-Design Submittal:
  - 1. Materials, fabrication, assembly, and spacing of hangers and supports.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
  - 1. Ceiling suspension assembly members.
  - 2. Size and location of initial access modules for acoustic tile.
  - 3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
- B. Field quality-control reports.

## **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, Operation and Maintenance Data, include the following:
  - 1. Instructions for resetting minimum and maximum air volumes.
  - 2. Instructions for adjusting software set points.

## **1.6 QUALITY ASSURANCE**

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Structural Performance: Hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".

### **2.2 SYSTEM DESCRIPTION**

- A. 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.

### **2.3 SHUTOFF, SINGLE-DUCT AIR TERMINAL UNITS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - 1. Titus.
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: single wall.
  - 1. Casing Lining: Adhesive attached, 1/2-inch- (13-mm-) thick, polyurethane foam insulation complying with UL 181 erosion requirements, and having a maximum flame-spread index of 25 and a maximum smoke-developed index of 50, for both insulation and adhesive, when tested according to ASTM E 84.
  - 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
  - 3. Air Outlet: S-slip and drive connections.
  - 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
  - 5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.

1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg (750-Pa) inlet static pressure.
  2. Damper Position: Normally open.
- E. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm), and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain valve.
- F. Direct Digital Controls: Bidirectional damper operators and microprocessor-based controller and room sensor. Control devices shall be compatible with temperature controls specified in Division 23, Instrumentation and Control for HVAC and shall have the following features:
1. Damper Actuator: 24 V, powered closed, spring return open.
  2. Terminal Unit Controller: Furnished by BAS, factory installed Pressure-independent, variable-air-volume controller with electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes, and having the following features:
    - a. Occupied and unoccupied operating mode.
    - b. Remote reset of airflow or temperature set points.
    - c. Adjusting and monitoring with portable terminal.
    - d. Communication with temperature-control system specified in Division 23, Instrumentation and Control for HVAC.
  3. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal. Refer to Division 23.
- G. Control Sequence:
1. Suitable for operation with duct pressures between 0.25- and 3.0-inch wg (60- and 750-Pa) inlet static pressure.

## **2.4 HANGERS AND SUPPORTS**

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Steel Cables: Galvanized steel complying with ASTM A 603.
- D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- E. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- F. Trapeze and Riser Supports: Steel shapes and plates for units with steel casings; aluminum for units with aluminum casings.

## **2.5 SOURCE QUALITY CONTROL**

- A. Factory Tests: Test assembled air terminal units according to ARI 880.
  1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, and ARI certification seal.



## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- B. Install wall-mounted sensors.

### **3.2 HANGER AND SUPPORT INSTALLATION**

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches (100 mm) thick.
  - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches (100 mm) thick.
  - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### **3.3 CONNECTIONS**

- A. Install piping adjacent to air terminal unit to allow service and maintenance.
- B. Hot-Water Piping: In addition to requirements in Division 23 connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.
- C. Connect ducts to air terminal units according to Division 23.

### **3.4 IDENTIFICATION**

- A. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Division 23 for equipment labels and warning signs and labels.

### **3.5 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

- C. Perform tests and inspections.
  - 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. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
  - 2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Air terminal unit shall be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

### **3.6 STARTUP SERVICE**

- A. Perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
  - 3. Verify that controls and control enclosure are accessible.
  - 4. Verify that control connections are complete.
  - 5. Verify that nameplate and identification tag are visible.
  - 6. Verify that controls respond to inputs as specified.

### **3.7 DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

**END OF SECTION 23 36 00**

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## **SECTION 23 57 00 - HEAT EXCHANGERS FOR HVAC**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes shell-and-tube and plate heat exchangers.

#### **1.3 SUBMITTALS**

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Coordination Drawings: Equipment room, 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. Tube-removal space.
  - 2. Structural members to which heat exchangers will be attached.
  - 3. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

#### **1.4 QUALITY ASSURANCE**

- A. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.
- B. Registration: Fabricate and label shell-and-tube heat exchangers to comply with the Tubular Exchanger Manufacturers Association's standards.

### **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.

#### **2.2 SHELL-AND-TUBE HEAT EXCHANGERS**

- A. Manufacturer shall be one of the following or approved equivalent:
  - 1. Amtrol
  - 2. Armstrong Pumps, Inc.
  - 3. Bell & Gossett.
  - 4. Patterson Kelly
  - 5. Taco, Inc.
- B. Configuration: U-tube as scheduled on drawings with removable bundle.

- C. Shell Materials: **Steel**. Shell design pressure shall be **150** psig. Shell test pressure shall be 300 psig.
- D. Head:
  - 1. Materials: **Fabricated steel with removable cover**.
  - 2. Flanged and bolted to shell.
- E. Tube:
  - 1. **Seamless copper** tubes.
  - 2. Tube diameter is determined by manufacturer based on service.
  - 3. Tube design pressure shall be **150** psig at 375 degrees F. Tube test pressure shall be **300** psig.
- F. Tubesheet Materials: **Steel** tubesheets.
- G. Baffles: **Steel**.
- H. Piping Connections:
  - 1. Shell: Inlet and outlet fluid connections (flanged or threaded) shall match piping specification requirements for the pipe connection sizes provided. , Threaded drain, and vent connections.
  - 2. Head: Inlet and outlet fluid connections (flanged or threaded) shall match piping specification requirements for the pipe connection sizes provided. .
- I. Support Saddles:
  - 1. Fabricated of material similar to shell.
  - 2. Foot mount with provision for anchoring to support.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 HEAT-EXCHANGER INSTALLATION**

- A. Install shell-and-tube heat exchangers on saddle supports.

#### **3.3 CONNECTIONS**

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Maintain manufacturer's recommended clearances for service and maintenance. Install piping connections to allow service and maintenance of heat exchangers.
- C. Install shutoff valves at heat-exchanger inlet and outlet connections.
- D. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain or to outdoors as indicated on equipment details.
- E. Install vacuum breaker at heat-exchanger steam inlet connection.
- F. Install hose end valve to drain shell.

### **3.4 FIELD QUALITY CONTROL**

- A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

### **3.5 CLEANING**

- A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

### **3.6 DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers. Refer to Division 01 Section "Demonstration and Training."

**END OF SECTION**

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## **SECTION 23 64 26 - VARIABLE SPEED SCREW WATER CHILLERS**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Chiller package.
- B. Charge of refrigerant and oil.
- C. Controls and control connections.
- D. Chilled water connections.
- E. Starters.
- F. Electrical power connections.

#### **1.2 RELATED SECTIONS**

- A. Section 23 09 00 - Instrumentation and control for HVAC.

#### **1.3 REFERENCES**

- A. ANSI/AHRI 550/590 - Standard for Water Chilling Packages using the Vapor Compression Cycle.
- B. AHRI 370 - Sound Rating of Large Outdoor Refrigerating and Air-Conditioning Equipment.
- C. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- D. ANSI/ASHRAE 90.1 - Energy Efficient Design of New Buildings.
- E. ANSI/ASME - Boiler and Pressure Vessel Code SEC VIII, Division 1.
- F. UL 1995 - Central Cooling Air Conditioners.
- G. ANSI/AFBMA 9-1978 - Load Ratings and Fatigue Life for Ball Bearings.
- H. IASTM B117 - Standard Method of Salt Spray (Fog) Testing
- I. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- J. ASTM A525 - Zinc (Hot-Dip Galvanized) Coatings on Sheet Steel Products
- K. ASTM D1654 - Evaluation of Painted or Coated Specimens, Subjected to Corrosive Environments
- L. IEEE519 - Harmonic Filtration Power Systems - the guideline relates to the entire system, not specifically to any one load or product. It establishes requirements at the point of common coupling (PCC) where the building connects to the utility system.

#### **1.4 SUBMITTALS**

- A. Submit dimensional plan and elevation view drawings, weights and loadings, required clearances, location and size of all field connections, electrical requirements and wiring diagrams.
- B. Submit product data indicating rated capacities, specialties and accessories.
- C. Submit manufacturer's installation instructions.

#### **1.5 OPERATION AND MAINTENANCE DATA**

- A. Submit operation data.
- B. Include start-up instructions, maintenance data, controls, and accessories.
- C. Submit maintenance data.

#### **1.6 REGULATORY REQUIREMENTS**

- A. Conform to AHRI 550/590 Standard for testing and certified rating of Water Chilling Packages using the Vapor Compression Cycle.
- B. Conform to ANSI/UL 1995 code for construction of water chillers. In the event the unit is not UL approved, the manufacturer shall, at manufacturer expense, provide for a field inspection by an UL representative to verify conformance to UL standards. If necessary, contractor shall perform modifications to the unit to comply with UL, as directed by the UL representative.
- C. Conform to ANSI/ASME Boiler and Pressure Vessel Code SEC 8 for construction and testing of water chillers.
- D. Conform to ANSI/ASHRAE 15 code for construction and operation of water chillers.
- E. Chiller must be built in an ISO 9001 classified facility.
- F. Conform to IEEE-519 for line voltage harmonics.

#### **1.7 STORAGE AND HANDLING**

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Unit controls shall be capable of withstanding 203 F (95 C) storage temperatures in the control compartment for an indefinite period of time.

#### **1.8 VERIFICATION OF CAPACITY AND EFFICIENCY**

- A. All proposals for chiller performance must include an AHRI approved selection method. Verification of date and version of computer program selection or catalog is available through AHRI.
- B. The chiller (one of each size) shall be factory performance tested in an ambient controlled, AHRI 550/590 approved test facility. The manufacturer shall supply a certified test report to confirm performance as specified. Proper AHRI certification documents for the test loop shall be made available upon request from the manufacturer for inspection. The performance test shall be conducted in accordance with AHRI Standard 550/590 procedures and tolerances.

1. The performance test shall be run with clean tubes in accordance with AHRI Standard 550/590 to include the following:
  - a. A downward temperature adjustment shall be made to the design leaving evaporator water temperature to adjust from the design fouling to the clean tube condition.
2. The factory test instrumentation shall be per AHRI Standard 550/590, and the calibration of all instrumentation shall be traceable to the National Institute of Standards and Technology (formerly NBS).
3. The following allowable tolerances must be referenced:
  - a. The tolerance on capacity shall be as defined by AHRI Standard 550/590 for full and part load points.
  - b. The tolerance on efficiency shall be defined by AHRI Standard 550/590 for IPLV/NPLV, full load and all part load test points.
4. A certified test report of all data shall be submitted to the Contracting Officer prior to completion of the project. The factory certified test report shall be signed by an officer of the manufacturer's company. Preprinted certification will not be acceptable; certification shall be in the original.

## **1.9 WARRANTY**

- A. Provide a full parts and labor warranty for five years from start-up or 18 months from shipment, whichever occurs first.
- B. In addition to the five year parts and labor warranty, manufacturer's service department to provide extended 5 year service contract including:
  1. One Seasonal Startup
  2. (4) Monthly Running Inspections
  3. One Annual Inspection/Kestrel View Inspection
  4. One Condenser Coil Cleaning

## **1.10 MAINTENANCE SERVICE**

- A. All inspections and service of units shall be accomplished by factory trained and authorized servicing technicians.
- B. OEM shall provide and report quarterly, annual, and bi-annual maintenance in compliance with or better than ASHRAE Standard 180-2008.
- C. Manufacturer's service technicians to provide extended 5 year service contract including:
  1. One Seasonal Startup
  2. (4) Monthly Running Inspections
  3. One Annual Inspection/Kestrel View Inspection
  4. One Condenser Coil Cleaning
- D. Submit copy of service call work orders and summary report to the Owner, including description of work performed, operating performance status and noted exceptions.

## **PART 2 - PRODUCTS**

### **2.1 SUMMARY**

- A. The contractor shall furnish and install air-cooled water chillers as shown as scheduled on the contract documents. The chillers shall be installed in accordance with this specification and perform at the specified conditions as scheduled.



- B. Acceptable Manufacturers or approved equivalent.
  - 1. Trane
  - 2. York
  - 3. Carrier
- C. Factory Functional Test: The chiller shall be pressure tested, evacuated and fully charged with R134a refrigerant and oil. In addition, a factory functional test to verify correct operation by cycling condenser fans, compressors and reading data points from temperature and pressure sensors.

## **2.2 COMPRESSORS**

- A. Construct chiller using semi-hermetic, direct-drive, helical rotary screw compressors with capacity control via a variable speed drive.
- B. Provide oil lubrication system with oil charging valve and oil filter to ensure adequate lubrication during starting, stopping, and normal operation.
- C. Provide compressor with automatic capacity reduction equipment consisting of a capacity control variable speed drive. The controls system logic must decelerate the compressor to minimum speed for a soft start.
- D. Provide direct-drive compressor motor that is suction gas cooled with robust construction and system design protection. Compressor starter shall be a variable speed drive to provide a soft start.
- E. Provide compressor heater to evaporate refrigerant returning to compressor during shut down. Energize heater when compressor is not operating.

## **2.3 EVAPORATOR**

- A. The evaporator shall be designed, tested, and stamped in accordance with ASME code for a refrigerant side working pressure of 200 psig. Waterside working pressure shall be 150 psig.
- B. Insulate the evaporator and water boxes with a minimum of 0.75 inch (K=0.28) UV rated insulation. If the insulation is field installed, the additional money to cover material and installation costs in the field should be included in the bid.
- C. Evaporator heaters shall be factory installed and shall protect unit down to -20 F. Contractor shall wire separate power to energize heat tape and protect cooler while chiller is disconnected from the main power.
- D. Provide shell and tube type evaporator, seamless or welded steel construction with cast iron or fabricated steel heads, seamless internally and externally finned copper tubes, roller expanded into tube sheets.
- E. Provide ability to remove evaporator tubes from either end of the heat exchanger.
- F. Provide water drain connection, vent and fittings for factory installed leaving water temperature control and low temperature cutout sensors.
- G. Water connections shall be grooved pipe. Evaporator shall have only one entering and one leaving connection. If manufacturer provides 2 separate evaporators, contractor shall provide manifold and pressure gauges to ensure equal flow is provided to each evaporator.
- H. Proof of flow shall be provided by the equipment manufacturer, mechanically installed and electrically wired, at the factory of origin.

## **2.4 CONDENSER AND FANS**

- A. Very Low Sound Fans shall be dynamically and statically balanced, direct drive, corrosion resistant glass fiber reinforced composite blades molded into a very low noise fan blade.
- B. All condenser fans shall have integrated drives to provide variable speed for optimized efficiency and lower part load sound.
- C. Chiller shall be able to start and operate in ambient conditions down to 0 deg. F (-17.8 deg. C) and up to 125 deg. F (52 deg.C). Wide ambient operation is accomplished with factory installed and tested protection. If field installed wide ambient solution is used this shall be purchased and installed at contractor expense.
- D. Construct condenser coils of aluminum fins mechanically bonded to internally finned long life tube alloy. The condenser coils shall have an integral subcooling circuit and shall be designed for 525 psig or higher working pressure.
- E. Provide factory installed louvered "architecturally pleasing" guard panels. Panel louvers shall cover condenser, evaporator and compressor sections so all are hidden from sight. Wire screens or wire mesh will not be allowed.

## **2.5 ENCLOSURES/STARTER**

- A. House components in a galvanized steel frame and mounted on a formed steel base. Hot-dip galvanized steel frame coating shall be Underwriters Laboratories Inc. (UL) recognized as G90-U, UL guide number DTHW2.
- B. Unit panels, base rails and control panels shall be finished with a baked on powder paint. Control panel doors shall have door stays. Paint system shall meet the requirements for outdoor equipment of Federal Government Agencies.
- C. Mount starters and Terminal Blocks in a UL 1995 rated weatherproof panel provided with full opening access doors. If a circuit breaker is chosen, it should be a lockable, through-the-door type with an operating handle and clearly visible from outside of unit indicating if power is on or off.
- D. Casings fabricated from steel that do not have a Zinc coating conforming to ASTM A 123 or ASTM A525 shall be treated for the prevention of corrosion with a factory coating or paint system. The coating or paint system shall withstand 1000 hours in a salt-spray fog test in accordance with ASTM B 117. Each specimen shall have a standard scribe mark as defined in ASTM D 1654. Upon completion of exposure, the coating or paint system shall be evaluated and rated in accordance with procedures A and B of ASTM D 1654. The rating of failure at the scribe mark shall be not less than six (average creepage not greater than 1/8 inch). The rating of the inscribed area shall not be less than ten (no failure). Thickness of coating or paint system on the actual equipment shall be identical to that on the test specimens with respect to materials, conditions of application, and dry-film thickness. For each compressor provide a variable speed drive starter. Across-the-line and Delta-Delta shall be unacceptable. If a variable speed drive starter is not applicable, wye-delta or solid state starter must be provided.
- E. A control power transformer shall be factory-installed and factory-wired to provide unit control power.

## **2.6 VARIABLE SPEED DRIVE**

- A. The water chiller shall be furnished with a variable speed drive (VSD) to minimize maintenance and maximize cooling efficiency. The VSD shall be factory mounted on the chiller and shipped completely factory assembled, wired and tested.

- B. The VSD will be specifically designed to interface with the water chiller controls and allow for the operating ranges and specific characteristics of the chiller. The VSD control logic shall optimize chiller efficiency by coordinating compressor motor speed to maintain the chilled water setpoint.
- C. The VSD efficiency shall be 95% or better at full speed and full load. Fundamental displacement power factor shall be a minimum of 0.95.
- D. The VSD shall be solid state, microprocessor based pulse-width modulated (PWM) design. The VSD shall be voltage and current regulated. Output power devices shall be IGBT transistors.
- E. Power semi-conductor and capacitor cooling shall be from a liquid cooled heatsink.
- F. The VSD shall have thin film capacitors.
  - 1. If thin film capacitors are not factory provided, then manufacturer should include a 5
- G. The following VSD status indicators shall be available to facilitate startup and maintenance:
  - 1. Output speed in hertz and rpm
  - 2. Input line voltage
  - 3. Input line kW
  - 4. Output/load amps
  - 5. Average current in percent RLA
  - 6. Load power factor
  - 7. Fault
  - 8. VSD transistor temperature
- H. The VSD shall include the following features:
  - 1. All control circuit voltages are physically and electrically isolated from power circuit voltage.
  - 2. Soft start, adjustable linear acceleration, coast-to-stop.
  - 3. Adjustable current limiting and UL approved electronic motor overload protection.
  - 4. Insensitivity to incoming power phase sequence.
  - 5. VSD and motor protection from the following faults:
    - a. Output line-to-line short circuit protection
    - b. Line-to-ground short circuit protection
    - c. Phase loss at AFD input
    - d. Phase reversal / Imbalance
    - e. Over-voltage / Under-voltage
    - f. Over temperature
- I. Warranties
  - 1. The variable speed drive shall be warranted by the manufacturer for a period of twelve months from the date of installation. The warranty shall include parts, labor, travel costs, and living expenses incurred by the manufacturer to provide factory-authorized on-site service.

## **2.7 REFRIGERANT CIRCUIT**

- A. All units shall have 2 refrigeration circuits to provide redundancy, each with one or two (manifolded) compressor(s) on each circuit.
- B. Provide for refrigerant circuit:
  - 1. Liquid line shutoff valve.
  - 2. Suction service valve
  - 3. Filter (replaceable core type).
  - 4. Liquid line sight glass.
  - 5. Electronic expansion valve sized for maximum operating pressure.
  - 6. Charging valve.
  - 7. Discharge and oil line check valves.
  - 8. High side pressure relief valve.

9. Full operating charge of HFC-134a and oil.
- C. Capacity Modulation: Provide capacity modulation by a variable speed drive. Unit shall be capable of operation down to 20 percent.

## 2.8 CONTROLS

- A. Chilled water temperature control shall be microprocessor-based, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied with each chiller by the chiller manufacturer. Controls shall include the following readouts and diagnostics:
1. Phase reversal/unbalance/single phasing and over/under voltage protection.
  2. Low chilled water temperature protection.
  3. High and low refrigerant pressure protection.
  4. Load limit thermostat to limit compressor loading on high return water temperature.
  5. Condenser fan sequencing to automatically cycle fans in response to load, expansion valve pressure, condenser pressure, and differential pressure to optimize unit efficiency.
  6. Display diagnostics.
  7. Oil pressure control based off of maintaining system differential pressure.
  8. Compressors: Status (on/off), percent RLA, anti-short cycle timer, and automatic compressor lead-lag.
- B. On chiller, mount weatherproof control panel, containing starters, power and control wiring, factory wired with terminal block power connection. Provide primary and secondary fused control power transformer and a single 115 volt 60 Hz single phase connection for evaporator freeze protection heaters.
1. The unit controller shall utilize the following components to automatically take action to prevent unit shutdown due to abnormal operating conditions which will perform as follows:
    - a. High pressure switch that is set 20 PSIG lower than factory pressure switch that will automatically unload the compressor to help prevent a high pressure condenser control trip. One switch is required for each compressor and indicating light shall also be provided.
    - b. Motor surge protector that is set at 95 percent of compressor RLA that will automatically unload the compressor to help prevent an over current trip. One protector is required for each compressor and indicating light shall also be provided.
    - c. Low pressure switch that is set at 5 PSIG above the factory low pressure switch that will automatically unload the compressor to help prevent a low evaporator temperature trip. One switch is required for each compressor and indicating light shall also be provided.
- C. In the above case, the chiller will continue to run in an unloaded state, and will continue to produce some chilled water in an attempt to meet the cooling load. However, if the chiller reaches the trip-out limits, the chiller controls will take the chiller off line for protection, and a manual reset will be required. Once the "near-trip" condition is corrected, the chiller will return to normal operation and can then produce full load cooling.
- D. Provide the following safety controls with indicating lights or diagnostic readouts.
1. Low chilled water temperature protection.
  2. High refrigerant pressure.
  3. Low oil flow protection.
  4. Loss of chilled water flow.
  5. Contact for remote emergency shutdown.
  6. Motor current overload.
  7. Phase reversal/unbalance/single phasing.
  8. Over/under voltage.
  9. Failure of water temperature sensor used by controller.
  10. Compressor status (on or off).

- E. Provide the following operating controls:
1. A variable method to control capacity in order to maintain leaving chilled water temperature based on PI algorithms. Five minute solid state anti-recycle timer to prevent compressor from short cycling. Compressor minimum stop-to-start time limit shall be 2 minutes. If a greater than 5 minute start-to-start, or greater than 2 minute stop-to-start timer is included, hot gas bypass shall be provided to insure accurate chilled water temperature control in light load applications.
  2. Chilled water pump output relay that closes when the chiller is given a signal to start.
  3. Load limit thermostat to limit compressor loading on high return water temperature to prevent nuisance trip outs.
  4. High ambient unloader pressure controller that unloads compressors to keep head pressure under control and help prevent high pressure nuisance trip outs on days when outside ambient is above design.
  5. Compressor current sensing unloader unit that unloads compressors to help prevent current overload nuisance trip outs.
  6. Auto lead-lag functions that constantly even out run hours and compressor starts automatically. If contractor cannot provide this function then cycle counter and hour meter shall be provided for each compressor so owner can be instructed by the contractor on how to manually change lead-lag on compressors and even out compressor starts and running hours.
  7. Low ambient lockout control with adjustable setpoint.
  8. Condenser fan sequencing which adjusts the speed of all fans automatically in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing unit efficiency.
- F. Provide user interface on the front of the panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels. Provide user interface with a minimum of the following features:
1. Leaving chilled water setpoint adjustment from LCD input
  2. Entering and leaving chilled water temperature output
  3. Percent RLA output for each compressor
  4. Pressure output of condenser
  5. Pressure output of evaporator
  6. Ambient temperature output
  7. Voltage output
  8. Current limit setpoint adjustment from LCD input.
- G. Provide factory installed contact closure input for initiation of ice building. Ice building termination shall be based on an adjustable entering water temperature setpoint. All compressors shall run at full load during ice building.
- H. Digital Communications to BAS system shall consist of a BACnet MS/TP interface via a single twisted pair wiring.
- I. The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.
- J. The chiller control panel shall provide an alarm relay output that shall energize whenever a fault requiring manual reset is detected by the panel.
- K. The chiller control panel shall provide input for leaving chilled water temperature setpoint based upon a 2-10VDC or 4-20mA signal from a building automation system.
- L. The chiller control panel shall provide input for chiller current limit setpoint based upon a 2-10VDC or 4-20mA signal from a building automation system.
- M. The chiller control panel shall provide an output for chiller Percent Capacity via a 2-10VDC or 4-20mA signal to a building automation system.

## **2.9 SOUND**

- A. At full load chiller sound pressure shall not exceed 60 dBA A-weighted at 30 feet from the side of the unit. At 50% load chiller sound pressure shall not exceed 55 dBA A-weighted at 30 feet from the side of the unit. Submitted sound data shall be in accordance with AHRI 370.
  - 1. If manufacturer cannot meet this sound specification then sound attenuation devices and/or barrier walls must be field installed at the contractor's expense to meet the specified level.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Align chiller package on steel or concrete foundations.
- C. Install units on level base and optional vibration isolators.
- D. Connect to electrical service.
- E. Connect to chilled water piping.
- F. Arrange piping for easy dismantling to permit tube cleaning.

### **3.2 MANUFACTURER'S FIELD SERVICES**

- A. OEM Startup is performed by factory trained and authorized servicing technicians confirming equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty.
  - 1. Included in OEM Factory Startup:
    - a. Centrifugal and Rotary Screw/Scroll Chillers
- B. Applied Chiller manufacturers shall maintain service capabilities no more than 100 miles from the jobsite.
- C. The manufacturer shall furnish an alternative price for:
  - 1. Extended compressor warranty for five years.
- D. The manufacturer shall furnish complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

**END OF SECTION**

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## **SECTION 23 74 13 – CUSTOM AIR HANDLING UNITS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This section includes:
  - 1. Custom air handling units.

#### **1.2 SUBMITTALS**

- A. Shop Drawings: Indicate assembly, unit dimensions (overall and each section), section and assembled unit weights, required clearances, construction details, and field connection details. Indicate layout of electrical components such as disconnect switches, motors, light switches, fixtures. Indicate layout of major control components and required clearance for maintenance. Include anchoring information; material, sizes, type, spacing of anchor bolts, and other required coordinating information.
- B. Product Data: Catalog sheets, brochures, performance charts, standard schematic drawings, specifications and installation instructions for each air handling unit.
- C. Contract Closeout Submittals: Operation and Maintenance Data: Deliver 2 copies, covering the installed products, to the Director's Representative.
- D. Wind loading and performance certification.

#### **1.3 QUALITY ASSURANCE**

- A. Source Quality Control: Factory test units in accordance with ARI Standard 430 - Central-Station Air-Handling Units.
- B. Perform Air Leak Test on all air handling and energy recovery units. Director shall witness test. Test pressure shall be plus or minus 12 inches w.g. Allowable in or out leakage shall not exceed 0.5% percent of design flow rate.
- C. Test fans for unbalance tolerances.
- D. Test cooling coils and drain pans for water leakage with full cabinet pressure applied. No water leakage allowed.

#### **1.4 DELIVERY, STORAGE AND HANDLING**

- A. Seal fluid and air openings prior to shipment.
- B. Deliver products to site in protective containers, with factory installed shipping skids and lifting lugs.
- C. Protect fan, motors, shafts and bearings during shipping, rigging, and from weather and construction dust.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
1. Ingenia
  2. Carrier
  3. Trane
  4. Ventrol

### **2.2 AIR HANDLING UNITS (AHU)**

- A. General: Customized indoor air handling units (AHUs) of double wall insulated design, shall include the following components as applicable, and unit sections shall include respective unit components, with multiple access sections, arranged as shown on the Drawings. Minimum outer dimensions and locations of duct connections shall be as shown on drawings.
1. Intake section. Include insulated, thermally broken Tamco damper, access door, lights and weatherproof light switches exterior of door.
  2. Access Sections: Provide with access doors, lights and weatherproof switches exterior of doors for access to various components.
  3. Filter Sections with face loaded prefilters, and final filters replaceable from upstream side. Refer to Division 23 for filters.
  4. Pre-conditioning coil section with glycol water. Provide coils with staggered vertical split for reduced coil pull.
  5. Cooling coil section with water. Provide coils with staggered vertical split for reduced coil pull.
  6. Coils of independently supported design with rack and removable panel section suitable for side-pull removal of coils. Vertical split coils to be removable from one side of each unit.
  7. Fan Sections with access doors, lights and weatherproof switches exterior of door. Provide Ziehl Abegg direct drive plenum fans with AC motors. Refer to Division 23 for fans and motors.
  8. Pre-wire lighting, switches and utility outlet in conduit, to a single external junction box for single 120 volt electric service connection.
  9. Provide factory mounted ACH 550 VFD with Eclipse bypass wired to motor. Include factory authorized start up by local representative
- B. Casings:
1. Complete no-through metal design.
  2. The section-to-section and panel-to-panel assembly of the unit shall be made exclusively with machine thread fasteners. Sheet metal screws of any sort are not permitted. Adjoining sections and panels shall have matched pairs of holes in one section and corresponding female threaded receiver permanently attached on the companion section and panel. They shall be engineered to be shipped fully assembled or in multiple sections ready to be field assembled and tested. Full length perimeter angles located inside units shall be provide at shipping splits to allow for field bolting of modular sections. Unit manufacturer shall provide all necessary hardware, gaskets, tape sealer, and caulk required to field join and seal the modular sections. The mating upper frame of each section shall also be fabricated with a flanged perimeter. The flanged perimeter shall be drilled with assembly clearance holes and be continuously gasketed.
  3. Base Frame: Construct from structural steel around the perimeter of the unit with intermediate channel and angle iron supports. Design base to carry maximum loading



- including rigging/shipping stresses. Minimum base height: 8 inches. Provide sufficient cross members, bracing and reinforcing as required.
4. Floor: Inner sheet; minimum 12 gauge aluminum treadplate with fully welded seams at all joints (no caulk allowed on floor) with safety tread surface. Outer sheet; minimum 16 gage galvanized sheet steel. Insulation; minimum 4 inch injected foam
    - a. All floors shall be recessed a minimum of 1 inch to form a drainable floor and be equipped with a section drain piped through the base to the unit exterior on the side determined by the engineer
  5. Walls: Insulated with minimum 3 inch injected foam. R 19.5, thermal bridging factor greater than 0.8 based on AHRI Standard 1350.
    - a. Skin; galvanized sheet steel, minimum 16 gage outer skin, minimum 18 gage inner skin.
    - b. All panels shall be of complete thermal break construction with no through-metal path between the interior and exterior. Panel construction shall utilize non-conductive HDPE blocking to thermally isolate all interior surfaces from all exterior surfaces and vice versa. Any method of no through-metal, thermal break that utilizes foam tape and/or fasteners in the direction of heat transmission is NOT ACCEPTABLE. All panels shall be double wall and fabricated of 16 gauge galvanized sheet steel outer shell with a 20 gauge stainless steel inner liner in all sections, chilled water coil section, heating coil section and humidifier section which shall have a solid 20 gauge Type 304 stainless steel liner. All panel seams will be externally caulked with sealant. There shall be no caulking exposed in the airstream. If a tubular framed construction is used, they must be of either galvanized or aluminum material with insulated tubes.
  6. Painting;
    - a. Powder coat exterior wall with factory applied electrostatic finish as described below
    - b. Powder coat interior and all interior static components with anti microbial white powder coat using AM Sterilcoat PC 17651 tested per JIS Z 2801 and as described below.
    - c. The powder coating process shall include: Pre-washing; Rinsing; Re-washing; Rinsing cycle I; Rinsing cycle II; Oven dry @ 400 deg F; Electrostatic paint application (powder format); Baked finish @ 400 deg F. Paint shall be applied in an electrostatic powder coating system. The electrostatic spraying shall be accomplished by applying an electrical charge to the dry powder particles while the component to be painted is electrically grounded. The charged powder and grounded work piece create an electrostatic field that pulls the paint particles to the work piece. The coating deposited on the work piece retains its charge, which holds the powder to the work piece. The coated work piece is placed in a curing oven, where the paint particles are melted onto the surface and the charge is dissipated. The paint system shall be environmentally friendly, therefore eliminating the use of volatile organic compounds (VOC's), hazardous air pollutants (HAP's) and solvents. Individual panels must be painted prior to final assembly to ensure painting of all sheared metal edges and concealed surfaces. The paint coating shall resist 4000 hours to the standard ASTM-B117 exposure salt spray test.
  7. Roof: Same as wall construction with (sloped roofs for installation outdoors).
  8. Drain Pans: 304 Stainless Steel, minimum 18 gage, sloped, double wall construction. Drain pipe of copper or stainless steel. The drain pan shall be insulated with 2.0 inch, 1-1/2 lb. density insulation to prevent condensation under the drain pan. Insulation shall be protected with an 18-gage galvanized steel liner. Drain pans must be sized such that the entire coil, including headers and return bends, are inside the drain pan. Drain pans must slope in two directions so there is no standing water in drain pan. Stainless steel condensate connection shall be provided on one side of the unit. Coils shall be supported on 10 gage stainless steel members to prevent immersion of the coil in condensate and allow for complete cleaning of drain pan beneath the coils.
  9. Thermal Performance; Maximum Thermal Conductivity: 0.0625 BTU/hour/square foot at 75 degrees F mean temperature.

C. Structural Performance

1. Design installation to be self-supporting with all applicable loadings for at least 125 percent of maximum shut-off pressure, positive or negative that fans can develop, with maximum deflection  $L/240$ .
  2. Provide additional strength by means of steel components such as heavier sheets, internal reinforcing members, structural columns, beams, channels or angles necessary for structural integrity. Incorporate such elements into panel structure without obstructing unit interior airflow or maintenance personnel traffic.
  3. Brace structure and rigidly support walls for required structural performance.
- D. Insulation
1. All panels shall be double wall construction, load-bearing and capable of forming the enclosure without additional structural members. All panel joints shall be sealed to provide a permanent air-tight seal. The panels shall have a maximum deflection of  $1/240$  at the specified conditions.
  2. Individual panels shall be made with two shells inter-connected to each other with intermediate High Density Polyethylene (HDPE) joining bridges to completely eliminate interior to exterior metal contact. HDPE joining bridges shall be installed at 12" intervals around the periphery of individual panels.
  3. All panels shall be a minimum 3" thick and be insulated with polyurethane foam having an R-value equal to 19.5, as tested by an independent lab using the following procedure: ASTM C1363-05 Standard Test Method for Thermal Performance of Building Materials and Envelop Assemblies by means of a hot box apparatus. The foam insulation shall not contain any Zero Ozone Depletion Substance (Zero ODS).
- E. Accessories
1. Joint insulation.
  2. U.L. classified sealer.
  3. Stainless steel machine screws. Sheet metal screws are not allowed
  4. Factory installed double wall, gasketed access doors with two hinges, two latches and double pane observation window with top of window located 6 feet above base of unit.
- F. Fabrication
1. Where units are sectionalized for field assembly, provide back to back channels, match drilled with permanently fixed female thread receptacles for each machine screw used to join the unit. Provide stainless steel machine screws for assembly of the sections.
    - a. In lieu of machine screws to join sections, continuous seam welding is acceptable provided the thermal bridging factor is met
  2. Weld base frame to inner sheet within double wall floor.
  3. Assemble panels and seal joints to limit total unit leakage to a maximum of .5 percent of specified capacity at plus or minus 12 inch total static pressure.
  4. Provide internal air tight seal between positive and negative sections of each unit.
  5. Provide sleeves and sealant for penetrations through casing except dampers.
  6. Provide temporary caps at piping and duct field connections.
  7. Provide sufficiently designed lifting lugs for each section. Within practical limits, provide a system for maximum number of assembled sections to be rigged.
  8. Indicate air flow direction inside and outside of casings.
  9. All interior joints are to be completely welded (floor) or caulked (walls and roof) for water seal. P
  10. All penetrations are to be sealed watertight.
  11. Access doors to be constructed in the same manner as the air handler casing using the same insulation and wall thickness. Each access door to have a viewing window and a pressure test port. All access doors to have stainless steel offset hinge and HDPE door jams.
- G. Fan Section

1. Fan Type: Single thickness, backwardly inclined or air foil centrifugal plenum fans. Double thickness air foil section is not approved due to possibility of internal corrosion. Variable frequency drive fans shall be one construction class rating above that required by (manufacturer's standard) fan performance. Refer to Division 26 for additional requirements.
  - a. Performance Ratings: Meet AMCA 210, with AMCA Certified Rating Seal.
  - b. Fans shall be capable of automated turndown through design range from maximum to minimum conditions without stall, surge or increased vibration.
  - c. Statically and dynamically balance fans at factory on their own shaft and bearings. Maximum unbalance allowed is in terms of displacement at a single frequency as follows:
 

RPM	DISPLACEMENT (mil thickness)
600	3.2
720	2.7
900	2.1
1200	1.6
1800	1.1
3600	0.5

Prior to balancing, remove all causes of vibration such as loose components, bearing misalignment, unbalanced sheaves, mismatched coupling and belts.
  - d. Where special coatings are specified, balance fans after coatings have been applied.
  - e. First critical speed shall be at least 25 percent higher of anticipated maximum operating rpm.
2. Mount fan and motor on welded steel base. Finish base with zinc chromate, iron oxide or phenolic resin paint.
3. Factory mount motor on slide rails. Provide for removal of fan wheel, motor, drive, fan shaft and bearings through removable casing panels, and/or access doors.
4. Internally isolate fans, motors and drive assembly on inertia base. Follow Division 23 and drawings.
5. Fan Shaft: Factory coated with rust and corrosion preventive compound.
6. Scheduled fan static pressure does not include losses sustained by vendor supplied equipment.
7. On fan housing, provide plugged outlet drain connection with standard hose connection.
8. Fan Manufacturer Finishing:
  - a. Exterior surfaces of fan housing and support stand: Two coats of exterior grade enamel over primer. Apply to ferrous metal components including galvanized surfaces and fan mounting bases. Fasteners for these fans shall be stainless steel, aluminum or other non-corroding material.
  - b. Interior surfaces of fans: One coat of exterior grade semi-gloss enamel over primer. Apply to ferrous metal components including galvanized surfaces and fan mounting bases.
9. Housing: Heavy gage steel, continuously welded construction for AMCA 99 required Class, adequately braced, designed to minimize turbulence with spun inlet bell and shaped cut-off. Support stand to also be constructed of all welded heavy gage steel members braced at corners with gusset plates welded to vertical, horizontal supports and fan housing. Provide bolted type gasketed clean-out door with hinges on scroll housing, and 1 inch plugged steel pipe coupling scroll drain welded to low point of fan scroll.
10. Flexible connections between fans and casing for vibration isolation.

H. Motors and Drives

1. Motors, Belts, Drives and Guards: Follow Division 23. Provide NEMA premium efficiency inverter duty motors meeting requirements of drive manufacturer.

2. Scheduled brake horsepower does not include drive losses.
3. Shafts: Solid hot rolled steel, ground and polished, with key-way. Coat with lubricating oil.

I. Coil Sections

1. For coil requirements, follow Division 23.
2. Enclose coils with headers and return bends fully contained within casing. Coils to be removable through access section doors. Allow for access to upstream side of coils.
3. Construct cooling and pre-heat/energy recovery coil channel frame casing, frame structure, drip and drain pans of stainless steel; Type 304L when bolting and Type 316L when welding connections. Crossbreak and pitch drain pans to drain connections. Provide for individual coil removal.
4. Provide each individual cooling coil with removable, full width rack for supporting low temperature detection (LTD) sensors. Design each rack to support averaging type sensors with 20 foot capillary lengths at a coverage rate of one linear foot of capillary for each square foot of coil face area. Locate rack immediately upstream of the coil. Each individual rack shall be removable without effecting operation of the remaining cooling coil sections. The rack design shall be such that the individual rack can be removed with the LTD device attached to the rack, requiring only removal of flexible conduit connection to the device and removing wiring terminations at each device.
5. Select coil capacities and pressure drops in accordance with ARI Standard 410.
6. Coil and drain pan connections shall be pre-piped at factory with external connections for field piping.

J. Silencers

1. Silencers shall be of the size, configuration, capacity and acoustic performance as scheduled on the drawings. All silencers shall be factory fabricated and supplied by the same manufacturer. Silencers shall be Ingenia.
2. The manufacturer shall have tested the silencers in full accordance with ASTM E-477-99 in an acoustic test facility. Test reports shall be made available to the project engineer.
3. AHU Silencers shall be made of continuous height baffles, thereby minimizing the use of intermediate modular blank-offs and maximizing acoustical absorption surface.

K. All acoustical baffles shall be constructed with 22 gauge (perforated aluminum, perforated galvanized steel).

L. Media shall be of acoustic quality, shot-free glass fiber insulation with long, resilient fibers bonded with a thermosetting resin. Glass fiber density and compression shall be as required to ensure conformance with laboratory test data. Glass fiber shall be packed with a minimum of 15 percent compression during silencer assembly. Media shall be bacteria and fungus resistant, resilient such that it will not crumble or break, and conforming to irregular surfaces. Media shall not cause or accelerate corrosion of aluminum or steel. Mineral wool will not be permitted as a substitute for glass fiber.

M. The acoustic media shall be completely wrapped with Tedlar film to help prevent shredding, erosion and impregnation.

N. Silencer materials, including acoustic media, Tedlar film shall have maximum combustion ratings as noted below when tested in accordance with ASTM E84, NFPA 255 or UL 723.

O. Flame spread classification: 20

P. Smoke developed rating: 45

Q. Filter Sections:

1. Casing construction with filter section access doors; face loading type housings, except where noted.

2. Types: As scheduled and shown on Drawings. Provide pre-filter and high efficiency filters in air handling units, and pre-filters in exhaust recovery units, in the arrangement shown on plans.
3. Gages: Differential pressure, diaphragm operated type (Dwyer Instruments Inc.; Magnehelic). Install across each filter bank. Range: 0 to 2 inches w.g. for 95 percent and 65 percent filters, 0 to 1 inch for 30 percent filter, with 0.05 inch w.g. increments. Provide "Tee" connections with caps for both "High" and "Low" pressure tap connections to gage, for dirty filter alarm on the Building Automation System (BAS). Refer to Division 23 for further requirements. Provide for reading each filter type pressure drop individually.
4. Maximum allowable bypass of air through or past each filter section is 1.0 percent of design air flow.

R. Channel Blenders

1. Provide Model #: Input Channel Blender P/N (ie: CB-100-02-02-00-01-00-00)
2. A dynamic air mixing component for the mixing box that integrates OA and RA control dampers into a device that will divide OA and RA into alternating adjacent channels with the control dampers located at the ends of each channel. These alternating OA and RA dampers will be oriented such that the air leaving an OA damper blade discharges into the air leaving an adjacent RA damper blade for the purpose of mixing OA and RA to eliminate freeze stat trips and to protect coils from freezing in a shorter distance than required by static mixing devices. The product shall be designed to provide freeze protection under the following conditions:
3. Freeze protection performance will be validated at these conditions in a report using computational fluid dynamics (CFD).
  - a. CFD report must include  $\Delta P$  for 100 percent of nominal CFM air flow through the unit to be channeled through the OA dampers only with the dampers positioned full open.
  - b. CFD report must include  $\Delta P$  for 50 percent of nominal CFM air flow through the RA channels and 50 percent of nominal CFM air flow through the OA channels with the dampers positioned full open.
  - c. Ratings
    - 1) Maximum Rated Pressure: 4 inch w.c.
    - 2) Maximum Rated Velocity: 3000 fpm
  - d. Channel walls are spaced approx. 4.6 inch apart to accommodate a 4 inch wide damper blade.
  - e. Channel walls separating OA and RA sections must be insulated to prevent condensation with RA conditions of 75 deg. F and 65 percent RH and OA at Minimum Design Ambient.
  - f. Channel structure must not be permanently deformed or the function of the dampers impacted by a  $\Delta P = 4$  inch w.c. between the RA and OA channels.
  - g. Damper frame is .080 inch Aluminum secured to the Channel Blender structure to prevent racking
    - 1) Dampers will be Class 1A low leakage dampers with 3 cfm/ft<sup>2</sup> of allowable leakage at 1 inch w.c.  $\Delta P$ .
    - 2) Dampers are extruded aluminum with EPDM seals mechanically secured into the damper blade.
    - 3) Damper shaft is 300 series stainless steel with a precision machined surface for mating/bearing to an aluminum precision drawn hole.

S. Dampers:

1. Provide Tamco dampers
  - a. Outside and relief air – Model 9000
  - b. Other dampers – Model 1000

T. Factory Testing

1. A factory performance test shall be performed for the custom roof-mounted air handling unit and the two custom indoor air handling units. The performance tests for the air handling units require that the air handling units are complete with fan, fan unit casing, and discharge

plenum coils and filters. Utilize the project VFD's, shipped to the air handling unit factory, for the testing. The performance test for the fans and the coils shall be a zero tolerance test. As specified hereinbefore, factory tests required for specified AHU's shall be witnessed by designated representatives of the Engineer and Owner (total five [5] people). The unit manufacturer shall notify the Construction Manager at least four (4) weeks prior to any scheduled testing and shall have a formal written report prepared at the conclusion of this testing to be submitted to the Engineer. The unit manufacturer shall pay for all air and ground transportation, lodging and meals for the designated witnesses to attend the testing. If multiple trips are required, they shall be paid for by the unit manufacturer. The performance tests for the air conditioning units shall be in multiple stages. A comprehensive performance testing and commissioning document, as described below, shall be forwarded to the Owner for review before testing commences. (Submit a minimum of five [5] copies.)

2. A document detailing the performance test installation and method of testing air handling units shall be submitted to the Owner for review before the testing program is executed. The document shall address the following:
  - a. Location where tests shall be performed.
  - b. Certification that location complies with AMCA Standards and is licensed under procedures of the AMCA Standards 300 and 301.
  - c. That the installation of the air handling units shall be tested in accordance with Installation B - free inlet ducted outlet as described in AMCA Standard 300.
  - d. All relevant manufacturers' performance data (e.g., fan curves, coil performance and column for entering test results).
  - e. Outline of proposed report format. This to detail performance assessments that shall be made and how they shall be determined.
  - f. Testing of Part Assemblies Prior to Approval of Pre-Production Units
    - 1) Fan: Fan manufacturer's standard certification, including vibration data at multiple load points of 25%, 50%, 75% and 100% of rated capacity.
    - 2) Coils: Coil manufacturer's standard tests and certification of coil design.
    - 3) Electric Wiring: Electrical supplier's standard certification.
    - 4) Variable Speed Motor Controller: Electrical and mechanical parameters of the drive system, including the combined efficiency of the controller and motor combination for each fan drive.
    - 5) Full details of all test equipment and instruments including test equipment calibration certificates.
    - 6) Comprehensive procedures for all tests and commissioning activities.
    - 7) Electrical and mechanical parameters of the drive system, including the combined efficiencies of the controller and motor combination for each fan drive.
  - g. The air handling unit manufacturer shall conduct testing in accordance with the ARI 350 Standard to demonstrate the acoustical performance of the air handling unit. The manufacturer shall report guaranteed maximum octave-band sound power levels in dB re 10-12 watts for, at a minimum, the casing radiated, unit intake and unit discharge. The acoustical measurements shall be made with the unit operating at 100%, 75%, 50% and 30% of design airflow capacity.
  - h. Cabinet Leak Testing: The cabinet shall be tested at the unit's design operating static pressure for both the high- and low-pressure sides. Cabinet leakage shall not exceed a Leakage Class rating of 9 as defined by ANSI/ASHRAE Standard 111. Unit leakage rate shall be less than 0.5% of unit capacity at 1.25 times the operating static pressure. Leak testing shall be performed by measuring the airflow pumped into (or out of) the unit at the cabinet design operating static pressure. All supply and return air openings shall be sealed along with the air seal at the supply fan to isolate the high and low side of the unit. The air shall then be pumped into (or out of) the unit until the appropriate operating pressures are achieved. Airflow measurements shall be performed in compliance with AMCA Standard 210. The testing shall be performed at the factory and witnessed by the Owner's representatives. A detailed report, including all data and test methods, shall be presented to the Owner.
  - i. Fan Vibration Testing: Fan wheel and shaft assemblies shall be dynamically analyzed after the fan, motor and drive assemblies have been installed in the unit. The fan shall be analyzed with an electronic balance analyzer with a tunable filter. Vibration

measurements shall be taken on each bearing housing in the horizontal, vertical, and axial positions with the filter tuned to the fan rpm. The testing shall be performed at the factory and witnessed by the Owner's representatives. A detailed report, including all data and test methods, shall be presented to the Owner.

- j. Sound Testing: The equipment manufacturer shall furnish calculations showing the estimated sound power levels at the supply and return connections, as well as unit casing radiation for each air conditioning unit. Calculations shall be based on fan sound power levels, which were determined in accordance with AMCA Standard 300 and 301. Casing transmission loss shall be as follows:
- k. In addition to the sound power level data included in the submittals, the manufacturer shall perform a sound test for each representative testable size unit. Testable size units shall be defined as units of less than 80,000 cfm that are less than 16 ft. wide and less than 65 ft. long. The tests shall verify for each size unit that the inlet and outlet sound power levels do not exceed the specified levels - in the first five octave bands 63 through 8000 - by more than is allowable by AMCA 311. A detailed report, including all data and test methods, shall be presented to the Owner or his representative(s).
- l. Variable Frequency Drives - The following tests shall be provided for each drive size, and shall be documented and performed in the presence of the Owner and/or their deemed representatives:
  - 1) Pre-production factory harmonics test, at all operating conditions, providing a hardcopy printout of complete three-phase harmonic voltage and current distortion content to the 25th harmonic, fundamental frequency power, current, voltage and power factor.
  - 2) Commissioning and performance test of each variable speed drive (as installed). Final acceptance test of each variable speed drive (as installed).
- m. Air Handling Unit Performance: Each factory-tested unit shall be tested to confirm the scheduled airflow and total static pressure for the supply and return air sections of the unit. Airflow (cfm) readings shall meet or exceed the specified airflow and the total static pressure (inches) of the fan section shall meet or exceed the specified static pressure as indicated in the schedules.

## **2.3 ELECTRICAL DEVICES AND WIRING**

- A. Conduit: Rigid type. Follow Division 26.
- B. Wiring: Install wiring in conduit. Follow Division 26.
- C. Each motor shall be factory wired to an NEMA 1 junction box mounted on the outside of the unit. Size wiring at minimum of 125 percent of motor full load amps in accordance with NEC.
- D. Each access section and the fan section shall be provided with a 115 volt fluorescent bulb type marine light having an impact resistant, plastic globe and wire guard. The unit lights shall be wired to a switch with pilot lights located on the outside of the unit.
- E. Provide a factory wired GFI type duplex electrical receptacle at one light switch.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install the Work of this Section in accordance with the manufacturer's printed instructions.
- B. Install indoor units level on support rails in accordance with manufacturer's instructions and reviewed submittals.

- C. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.
- D. Coordinate location of casing sleeves, internal pipe and supports. Seal all openings.
- E. Assemble and join units at shipping splits in accordance with manufacturer's recommendations.

### **3.2 FIELD QUALITY CONTROL**

- A. Field Testing:
  - 1. Perform leak testing on completely assembled air handling units. Test positive and negative sections separately with normal access doors installed (blank offs not allowed). Director and/or Designer reserve right to witness tests.
  - 2. Leak Test: Blank off unit outside air and return air inlets, and fan's unit discharge. Use leak test apparatus as specified in AABC Standards. Unit leakage shall not exceed 1.0 percent of scheduled CFM at plus or minus 10 inches w.g. Leak test under "negative" pressure or "positive" pressure as applicable.
  - 3. Where testing results in failure, submit written notification describing proposed corrective action. Do not take corrective measures until steps are approved. After approval, perform corrective measures, and retest until work meets specified performance.
- B. If installation is not by AHU/ERUs/ERW manufacturer, provide services of unit manufacturer's representative, to supervise field disassembly and assembly of unit modules.

END OF SECTION

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## **SECTION 23 82 36 - PANEL RADIATOR HEATER**

### **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. Hydronic radiant heating and cooling ceiling panels

#### **1.3 DEFINITIONS**

- A. Low voltage: as defined in NFPA 70 for circuits and equipment operating at less than 50V or for remote control, signaling and power limited circuits.

#### **1.4 SUBMITTALS**

- A. Product data: includes rated capacities, specialties and accessories for each product indicated.
- B. Shop drawings: Include plans, elevations, sections, details and attachments to other work. Indicate dimensions, weights, loads, required clearances, method of field assembly, components and location and size of each field connection.
  - 1. Include schedule showing model designation, size, room location and accessories furnished.
  - 2. IOM
- 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. Suspended ceiling components
  - 2. Method of attaching hanging systems to building structure.
  - 3. Size and location of initial access modules for acoustical tile.
  - 4. Items penetrating finished ceiling, including the following:
    - a. Lighting fixtures
    - b. Air outlets and inlets
    - c. Speakers
    - d. Sprinklers
    - e. Access panels
  - 5. Perimeter moldings
- D. Samples for initial selection: for units with factory applied color finishes.

#### **1.5 QUALITY**

- A. Product Options: Drawings indicating size, profiles, and dimensional requirements of radiant ceiling panels.

- B. Radiant ceiling panels shall be shipped with an adhesive film protective coating on each individual element on the visual side.
- C. Radiant ceiling manufacturer to supply 5 year warranty from date of shipment.
- D. Panels to be manufactured in a certified ISO9001:2015 facility.
- E. Radiant ceiling panels and accessories shall be rated and tested for pressures as shown on drawings and manufacturers technical documentation.

## **1.6 COORDINATION**

- A. Coordinate layout and installation of radiant panels and suspension components 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. Manufacturers: subject to compliance with requirements, provide products by one of the following:
  1. Zehnder
  2. Alternates: Approved equals if that substitution meets the design criteria.

### **2.2 HYDRONIC RADIANT HEATING AND COOLING CEILING PANELS**

- A. Material:
  1. Heating performance capacity shall be tested and certified by manufacturer in accordance with DIN 14037 or ASHRAE 138-2013
  2. Radiant ceiling panels to include activation, copper meander, steel cassette and supported steel cross channels.
  3. Panel Surface: All panels to have perforation pattern consisting of 2mm (0.08") diameter holes providing 22% open area as standard. Perforated panels to be supplied with an acoustical absorbing fleece for sound attenuation. The microfiber fleece shall be non-flammable and meet the requirements of building material standards DIN 4102/B1 and BS 476/ASTM E84.
  4. Sound absorption data shall be available for all panel configurations and tested in accordance with ASTM C423-02 or DIN EN ISO 354.
  5. Factory cut outs shall be supplied for radiant panels for integration with lights, projector brackets, speakers, fire sprinklers, and other air outlet devices.
  6. Radiant ceiling panel surface to be coated with highly emissive powder coat paint for optimal radiative properties. Color to be selected by architect.
  7. Copper meander to be supplied with same end, opposite end or 2X meander connections based on drawings.
  8. Radiant panels shall be 2-pipe.
  9. Radiant ceiling panels to be supplied with the following edges:
    - a. Free Hanging, Sail or Cloud
  10. Free hanging, cloud or sail panels shall be factory supplied with backclips to eliminate gaps.
  11. Factory installed fire resistant 1" Rockfon insulation shall be provided with glass lined fiber fleece to provide acoustical absorption and shall have ASTM E85 / ASTM E1264 classification.
  12. Flexible hoses to be supplied with panels for connections to surrounding panels and distribution system. Panel connection by means by brazing or press is not acceptable.
  13. Factory supplied mounting and hanging hardware for radiant panels.

## **PART 3 - EXECUTION**

### **3.1 PRE-DESIGN SERVICES**

- A. Bid shall include the costs to complete final selections and coordination with the Engineer at the Engineers office. Allow for a minimum of three (3) days.

### **3.2 INSTALLATION – GENERAL**

- A. Install radiant panel level and plumb. Maintain sufficient clearance for normal services, maintenance, or in accordance with construction drawings.
- B. To ensure proper installation and handling of the radiant panels, a complete IOM shall be supplied and reviewed before installation has begun.
- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
  - 1. Verify that controls and control enclosure are accessible.
  - 2. Verify that control connections are complete to control valves as needed.
  - 3. Verify that any identification tags are visible.
  - 4. Verify that controls respond to inputs as specified.
  - 5. Removal of protective film coating before system startup.
  - 6. Release of stabilization profiles on panel edges.

### **3.3 CONNECTIONS**

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicated general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to radiant panels to allow for service and maintenance.
- C. In addition to Division 23 Section "Hydronic Piping", connect copper tubing to supply with shut-off valve, strainer, control valve, and union or flange, and to return with balancing valve and union or flange.

### **3.4 FIELD QUALITY CONTROL**

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. Leak Test: After installation, fill water tubes and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to conform to proper unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

### **3.5 CLEANING AND PROTECTION**

- A. Remove protective film coating before startup of the system.
- B. Clean all visible surfaces of equipment; touch up as required.
- C. Protect all units before, during and after installation. Damaged materials due to improper protection shall be cause for rejection.

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## **SECTION 23 82 39.16 - PROPELLER UNIT HEATERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes propeller unit heaters with hot-water coils.

#### **1.3 DEFINITIONS**

- A. BAS: Building automation system.
- B. CWP: Cold working pressure.
- C. PTFE: Polytetrafluoroethylene plastic.
- D. TFE: Tetrafluoroethylene plastic.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include location and size of each field connection.
  - 4. Include details of anchorages and attachments to structure and to supported equipment.
  - 5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
  - 6. Indicate location and arrangement of piping valves and specialties.
  - 7. Indicate location and arrangement of integral controls.
  - 8. Wiring Diagrams: Power, signal, and control wiring.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Suspended ceiling components.
  - 2. Structural members to which propeller unit heaters will be attached.
  - 3. Method of attaching hangers to building structure.
  - 4. Size and location of initial access modules for acoustical tile.
  - 5. Items penetrating finished ceiling, including the following:
    - a. Lighting fixtures.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
- B. Field quality-control reports.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following or approved equivalent:
  - 1. Airtherm; a Mestek company.
  - 2. Engineered Air.
  - 3. McQuay International.
  - 4. Modine
  - 5. Rosemex Products.
  - 6. Ruffneck Heaters; a division of Lexa Corporation.
  - 7. Trane Inc.

### 2.2 DESCRIPTION

- A. Assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.
- B. 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.
- C. Comply with UL 2021.

## **2.3 PERFORMANCE REQUIREMENTS**

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

## **2.4 HOUSINGS**

- A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

## **2.5 COILS**

- A. General Coil Requirements: Test and rate hot-water propeller unit-heater coils according to ASHRAE 33.
- B. Hot-Water Coil: Copper tube, minimum 0.025-inch (0.635-mm) wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 200 psig (1380 kPa) and a maximum entering-water temperature of 325 deg F (163 deg C), with manual air vent. Test for leaks to 350 psig (2413 kPa) underwater.

## **2.6 FAN AND MOTOR**

- A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- B. Motor: Permanently lubricated, multispeed. Comply with requirements in Division 23, Common Motor Requirements for HVAC Equipment.

## **2.7 CONTROLS**

- A. Control Devices:
  - 1. Unit-mounted, variable fan-speed switch.
  - 2. Wall-mounted thermostat.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install propeller unit heaters to comply with NFPA 90A.
- B. Install propeller unit heaters level and plumb.
- C. Suspend propeller unit heaters from structure with all-thread hanger rods and hangers specified in Division 23, Hangers and Supports for HVAC Piping and Equipment. Vibration hangers are specified in Division 23, Vibration and Controls for HVAC Piping and Equipment.

### **3.3 CONNECTIONS**

- A. Piping installation requirements are specified in Division 23. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to propeller unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
- D. Comply with safety requirements in UL 1995.
- E. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of propeller unit heater. Hydronic specialties are specified in Division 23, Hydronic Piping.
- F. Ground equipment according to Division 26.
- G. Connect wiring according to Division 26.

### **3.4 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

**END OF SECTION**

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## **SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20, HVAC, Section 20 00 00, "Common Mechanical and Electrical Requirements." To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Electrical equipment coordination and installation.
  - 2. Sleeves for raceways and cables.
  - 3. Sleeve seals.
  - 4. Grout.
  - 5. Common electrical installation requirements.

#### **1.3 DEFINITIONS**

- A. EPDM: Ethylene propylene diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.

#### **1.4 SUBMITTALS**

- A. Product Data: For sleeve seals.

#### **1.5 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 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 08 Section "Access Doors and Frames."
- D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Firestopping."
- E. Coordinate connection requirements for equipment provided by other trades with equipment submittals and vendor-specific requirements prior to installation and electrical rough-in, including verification of exact location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.

- F. Coordinate connection requirements for equipment provided by Owner and Architect with the equipment submittals prior to ordering and delivery of associated wiring devices, installation of associated wiring devices and electrical rough-in.

## **1.6 MATERIALS AND WORKMANSHIP**

- A. Work shall be neat and rectilinear to building structure. Install material and equipment in accordance with manufacturers written instructions. Installation shall operate safely and without noise, vibration or corrosion. Work shall be properly and effectively protected, and raceway openings shall be temporarily closed to prevent obstruction and damage before completion.
- B. Except as specified otherwise, material and equipment shall be new, factory tested and delivered ready for field installation. Provide supplies, accessories and connections necessary for complete and operational installation. Provide components required or recommended by OSHA and applicable NFPA documents. Equipment damaged during installation shall be repaired to new condition or replaced with new material. The Contractor shall be responsible for all costs associated with testing, replacing to repair, including but not limited to, all replacement or repair costs, preparations prior to testing, all testing costs, extended warranties, re-commissioning of the equipment, etc. with no additional cost to the contract.
- C. Ensure materials and equipment can be delivered and installed in sections sufficiently small to fit within available openings in the building, and that the weight and size of individual equipment pieces and sections do not exceed the capacity of the utilized hoisting and elevator systems.
- D. Owner will not be responsible for material and equipment before testing, commissioning, and acceptance.

## **1.7 EQUIPMENT LOCATION**

- A. Location of outlets and devices shall be verified with the Architect prior to roughing in. Refer to details and elevations on the Architectural Drawings. Mounting heights indicated on the Architectural Drawings shall take precedence over information indicated on the Electrical Drawings.
- B. If discrepancies regarding the locations of outlet boxes exist between the Electrical Drawings and any other drawings associated with the Project, notify the Architect. Any reasonable change in location of outlets shall not involve additional expense to Owner. The term "reasonable" shall be interpreted as moving outlet 10'-0" in any direction from the location indicated on the Electrical Drawings.

## **1.8 CABLE TERMINATION TEMPERATURE RATINGS**

- A. Equipment terminations connecting to wire and cable, rated 600V or less, shall be rated no less than for 75 deg. C for conductors 1 AWG and smaller and/or where conductor ampacities are 100 A or less.

## **PART 2 - PRODUCTS**

### **2.1 SLEEVES FOR RACEWAYS AND 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. Sleeves for Rectangular Openings: Galvanized sheet steel.
  - 1. Minimum Metal Thickness:
    - a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
    - b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

## **2.2 SLEEVE SEALS**

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Advance Products & Systems, Inc.
  - 2. Calpico, Inc.
  - 3. Metraflex Co.
  - 4. Pipeline Seal and Insulator, Inc.
- C. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
- D. Pressure Plates: Carbon steel. Include two for each sealing element.
- E. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

## **2.3 GROUT**

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

## **2.4 ACCESS AND ACCESS PANELS**

- A. This Section supplements requirements of Division 08.
- B. Description: Interior construction access panels.
- C. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Milcor
  - 2. Knapp
  - 3. Nystorm
  - 4. Inland Steel
- D. Coordinate selection with other Sections supplying similar access panels.
- E. Access panels shall have same fire rating classification as surface penetrated.

## **PART 3 - EXECUTION**

### **3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION**

- A. Comply with NECA 1.
- B. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways, to satisfaction of Architect and in accordance with code requirements. Installation shall permit clearance for access to equipment for repair, servicing and replacement.
- C. Install equipment so as to properly distribute equipment loads on building structural members provided for equipment support under other Sections. Roof-mounted equipment shall be installed and supported on structural steel provided under other Sections.
- D. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs as necessary for floor, wall or ceiling mounting of equipment as required.
- E. Provide steel supports and hardware for proper installation of hangers, anchors, guides, etc.
- F. Provide cuts, weights, and other pertinent data required for proper coordination of equipment support provisions and installation.

- G. Structural steel and hardware shall conform to Standard Specifications of ASTM; use of steel and hardware shall conform to requirements of Section Five of Code of Standard Practice for Steel Buildings and Bridges.
- H. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly which may void warrantee. Report in writing to Architect, prior to purchase or shipment of equipment involved, on conditions which may prevent proper installation.
- I. No equipment, ductwork, or piping foreign to the electrical installation shall be installed or pass through any room in which electrical systems or equipment is located, such as electrical room, electric closets telephone or data closets. The Electrical Contractor shall notify the Construction Manager of such violations and request removal of such equipment, ductwork, or piping.
- J. Coordinate location of variable frequency controllers, panelboards, transformers and other electrical equipment installed in mechanical rooms with the associated subcontractors. No piping, ductwork or other mechanical equipment shall be allowed to pass through the area of the electrical equipment equal to the width and depth of the electrical equipment extending from floor to structural ceiling above. A hung or gypsum board ceiling is not considered structure.
- K. Give right of way to piping systems installed at a required slope and/or specific mounting height or elevation.
- L. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.
- M. 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.
- N. 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.
- O. Right of Way: Give to piping systems installed at a required slope.

### **3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS**

- A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.
- B. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Firestopping."
- C. 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.
- D. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
- E. 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.
- F. Cut sleeves to length for mounting flush with both surfaces of walls.
- G. Extend sleeves installed in floors 2 inches above finished floor level.
- H. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.
- I. Seal space outside of sleeves with grout for penetrations of concrete and masonry. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.
- J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

- K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Firestopping."
- L. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- N. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

### **3.3 SLEEVE-SEAL INSTALLATION**

- A. Install to seal exterior wall penetrations.
- B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### **3.4 FIRESTOPPING**

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Firestopping."

### **3.5 HVAC, PLUMBING AND FIRE PROTECTION CONNECTIONS**

- A. General
  - 1. Provide all power wiring including all circuitry carrying electrical energy from panelboard or other source through starters and disconnects to motors or to packaged control panels. Packaged control panels may include disconnects and starters and overcurrent protection. Provide all wiring between packaged control panels and motors.
  - 2. HVAC, Plumbing and Fire Protection equipment is defined as products provided under other divisions that require power 120 volts and higher.
  - 3. Provide conduit and power wiring for connection to alarm panels, remote alarms, etc. Refer to HVAC, Plumbing and Fire Protection drawings for location and quantity of panels/alarms to be connected. Provide connections from local 120-volt panel via 20 ampere circuit breaker.
- B. Coordination
  - 1. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.
- C. Examination
  - 1. Examine the areas and conditions under which the equipment is to be installed.
  - 2. Verify that equipment is ready for electrical connection, wiring, and energization.
- D. Installation
  - 1. Use wire and cable with insulation suitable for temperatures encountered in heat-producing equipment.
  - 2. Make conduit connections to vibrating equipment using flexible conduit. Use liquid tight flexible conduit in damp or wet locations.

3. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.
  4. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes for vibrating equipment.
  5. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.
  6. Install disconnect switches, controllers, control stations, and control devices such as limit switches and temperature switches as indicated. Connect with conduit and wiring as indicated.
  7. Each motor terminal box shall be connected with a minimum 12", maximum 24" piece of flexible conduit to a fixed junction box. A green wire run through the flexible conduit shall interconnect the motor frame and the branch circuit ground wire. Use liquid tight flexible metal conduit for connection. Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.
  8. Check for proper rotation of each motor.
- E. Building Management Panels
1. Provide conduit and power wiring (120 volt) to all Building Management System Panels, Direct Digital Control panels, Utility Monitoring System (UMS) panels, etc. Provide connection from local 120 volt panel via 20 ampere circuit breaker. Provide one branch circuit for every panel, unless indicated otherwise. Coordinate power and circuiting requirements with associated system vendors.

### **3.6 ACCESS PANELS**

- A. Provide access panels in accordance with this Section and requirements of Division 08.
- B. Access panels are generally not shown on the drawings, but shall be provided as required to allow access to system components.
- C. Provide proper access to materials and equipment that require inspection, replacement, repair or service, and coordinate their delivery with the installing Trade. If proper access cannot be provided, confer with Architect as to best method of approach for minimizing effect of reduced access which may result.
- D. Coordinate and prepare a location, size, and function schedule of access panels required to fully service equipment and deliver to a representative of the installing Trade. Furnish and install distinctively colored buttons (color as selected by Architect) in finished ceiling to identify all access panels.
- E. Provide access panels to all items requiring maintenance including at fire dampers, volume dampers, controls, shut-off valves, control valves, check valves, or other items that require access and are concealed in floor, wall, furred space or above ceiling.
- F. Ceilings consisting of lay-in or removable splined tiles do not require access panels and dampers, splitters, or test hole openings above ceiling shall have location marked with thumb tack on finished ceiling panel. Location shall be noted on Record Drawings.
- G. Access panels shall have same fire rating classification as surface penetrated.
- H. Panels within 8" of the surface being penetrated shall be the sized for the greater of 12"x12" or size required to allow removal of the component being maintained; panels further than 8" from the surface being penetrated and access at all equipment requiring service (including disconnects) shall be a minimum of 24"x24". Access doors to fire dampers shall be a minimum of 18"x16" if fire damper is within ordinary person's arms reach of the access panel or 24"x24" if beyond arms reach as required by NFPA 90A.

### 3.7 CONNECTIONS TO OWNER AND ARCHITECT EQUIPMENT

#### A. General

1. Provide all power wiring including all circuitry carrying electrical energy from panelboard or other source to Owner and architectural equipment for complete and operational equipment.
2. Owner and Architectural equipment includes, but is not limited to, the following:
  - a. Coffee machines
  - b. Vending machines
  - c. Microwaves
  - d. Cooktops
  - e. Ovens
  - f. Ranges
  - g. Refrigerators
  - h. Freezers
  - i. Dishwashers
  - j. Copy machines
  - k. Projector screens
  - l. Trash Compactors
  - m. Motorized doors
  - n. Overhead coiling doors
  - o. Electric hand dryers

#### B. Coordination

1. Coordinate location of equipment with Architect and Owner.
2. Review equipment submittals prior to ordering and delivery of associated wiring devices, installation of associated wiring devices and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.
3. Obtain wiring diagrams and installation methods from equipment manufacturers.

#### C. Examination

1. Examine the areas and conditions under which the equipment is to be installed.
2. Verify that equipment is ready for electrical connection, wiring, and energization.

#### D. Installation

1. Make conduit connections to vibrating equipment using flexible conduit. Use liquid tight flexible conduit in damp or wet locations.
2. Install pre-finished cord set where connection with attachment plug is indicated or specified, or use attachment plug with suitable strain-relief clamps.
3. Provide suitable strain-relief clamps for cord connections to outlet boxes and equipment connection boxes for vibrating equipment or for cord drops from ceilings.
4. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.
5. Each motor terminal box shall be connected with a minimum 12", maximum 24" piece of flexible conduit to a fixed junction box. A green wire run through the flexible conduit shall

interconnect the motor frame and the branch circuit ground wire. Use liquid tight flexible metal conduit for connection. Conduit must be installed perpendicular to direction of equipment vibration to allow conduit to freely flex.

6. Check for proper rotation of each motor.

### **3.8 ELECTRICAL INSTALLATION FOR ELEVATORS**

#### **A. General**

1. Provide electrical power and auxiliary services to elevators as described and as amended by the elevator contract shop drawings and specifications. Prior to installation, Electrical Contractor shall coordinate work with Elevator Contractor.

#### **B. Coordination**

1. Review equipment submittals prior to installation and electrical rough-in. Verify location, size, and type of connections. Coordinate details of equipment connections with supplier and installer.
2. Coordinate entire installation with Division 11 Contractor prior to rough-in.

#### **C. Examination**

1. Verify that equipment is ready for electrical connection, wiring, and energization.

#### **D. Installation**

1. Make wiring connections in control panel or in wiring compartment of pre-wired equipment in accordance with manufacturer's instructions. Provide interconnecting wiring where indicated.
2. Provide all power wiring from source through disconnect to elevator controller to motor.

#### **E. Provide the following auxiliary services to the elevator pit for each elevator. Locate and identify all services as directed by elevator shop drawings or Elevator Contractor.**

1. Elevator pit shall be provided with vapor-tight lighting fixture with polycarbonate lens switched from the entrance of elevator pit served by a dedicated branch circuit. Do not wire light fixture on GFI circuit.
2. Provide 120 volt, 20 ampere dedicated GFI receptacle in each elevator pit served by a dedicated branch circuit.
3. Two adjacent elevators may share a common branch circuit for receptacles and a common branch circuit for lights unless shown or directed otherwise on the contract drawings.
4. Where provided, connect to sump pump in elevator pit with dedicated branch circuit.

#### **F. Provide the following auxiliary services to the elevator machine room for each elevator. Locate and identify all services as directed by elevator shop drawings or Elevator Contractor.**

1. Cab lighting: Provide manual switch labeled "cab lights" adjacent to power disconnect. Extend 120 volt circuit from source through lockable switch to controller. Provide one lockable switch and 120-volt circuit per unit.
2. Cab telephone: Junction box with 1" conduit to local telephone backboard.
3. Cab security: Junction box with 1" conduit to local security backboard.
4. Controller: Provide separate 120 volt, single phase, 20 ampere circuit to lockable thermal overload switch.
5. Group Controller: Provide separate 120 volt, single phase, 20 ampere circuit to lockable thermal overload switch.
6. Receptacles: Provide a 120 volt, 20 ampere dedicated GFI receptacle within each elevator machine room served by a dedicated branch circuit.



7. Intercom System: Provide 120 volt, 20-ampere branch circuit.

### **3.9 CLEANING**

- A. Cleaning shall be performed on a day-to-day basis and a final cleaning prior to commissioning.
- B. Equipment
  - 1. All electrical equipment shall be cleaned inside and out prior to initial energizing.
  - 2. Cleaning shall consist of vacuuming busses, windings, enclosures (inside and out), etc. After vacuuming is complete, the equipment shall be wiped down.
  - 3. If equipment is wet or contains moisture, it shall be thoroughly dried out and inspected by the manufacturer's representative before energizing.
- C. Raceways
  - 1. All raceways shall be blown out and dried prior to installation of conductors.
  - 2. Raceways installed in or below the slab shall have a mandrel pulled through to clear any dirt and debris.
- D. Pull, Junction, Work and Floor Boxes
  - 1. All boxes shall be cleaned of debris such as plaster and concrete residue prior to installation of conductors.
  - 2. Vacuum all dirt and debris from floor boxes prior to installing inserts.
- E. Electrical Rooms
  - 1. Upon completion of cleaning equipment, raceways and boxes, but before energizing equipment, the entire room shall be swept clean with all garbage removed from the area.
  - 2. When the room is clean and equipment energized, the area shall remain clean and the doors to the room shall remain closed until completion of project.
  - 3. If the room or equipment is subjected to dust or moisture after energizing the equipment shall be de-energized and re-cleaned as outlined above.
- F. Final Cleaning
  - 1. All light fixtures, devices, device plates, etc., shall be cleaned and left in new condition to the satisfaction of the Architect, prior to final occupancy.
  - 2. All rubbish, discarded materials and unused materials shall be removed from site.

END OF SECTION 26 05 00

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## **SECTION 26 05 13 - 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 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes cables and related cable splices, terminations, and accessories for medium-voltage electrical distribution systems.

#### **1.3 DEFINITIONS**

- A. Jacket: A continuous nonmetallic outer covering for conductors or cables.
- B. NETA ATS: Acceptance Testing Specification.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of cable, termination, separable connector and cable accessory. Submit product data for all items specified under this Section in a single comprehensive Product Data Submittal Package. This Submittal Package shall contain only items specified under, or directly related to, this Section. Submittals that do not include each specified unit or contain incomplete submittal information will be rejected.
- B. Coordination Drawings: Indicate location of each cable, splice, and termination.
- C. Qualification Data: For Installer and testing agency.
- D. Material Certificates: For each cable and accessory type, signed by manufacturers.
- E. Source quality-control reports.
- F. Field quality-control reports.

#### **1.5 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: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- 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.

#### **1.6 PROJECT CONDITIONS**

- A. 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 Owner, Architect and Construction Manager no fewer than 14 days in advance of proposed interruption of electric service.
  - 2. Do not proceed with interruption of electric service without Owner's, Architect's and Construction Manager's written permission.

## **PART 2 - PRODUCTS**

### **2.1 CABLES**

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  2. General Cable Technologies Corporation.
  3. Okonite Company (The).
  4. Prysmian Group.
  5. Southwire Company, LLC.
- A. Cable Type: Type MV 105.
- B. Conductor Insulation: Ethylene-propylene rubber.
  1. Voltage Rating: 15 kV.
  2. Insulation Thickness: 133 percent insulation level.
- C. Conductor: Single, annealed, stranded copper, 98 percent conductivity at 20 degrees C.
- D. Comply with UL 1072, AEIC CS8, ICEA S-93-639/NEMA WC 74, and ICEA S-97-682.
- E. Conductor Stranding: Concentric lay, Class B.
- F. Shielding: 5 mil bare uncoated copper tape, helically applied (with minimum 12.5 percent overlap) over semiconducting insulation shield.
- G. Cable Jacket: Sunlight-resistant PVC.
- H. Cable must be manufactured no more than 12 months prior to delivery to Project site.
- I. Provide test tails for each cable reel delivered to Project site to facilitate on-reel testing specified.

### **2.2 SOLID TERMINATIONS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Raychem Corp.; Tyco International Ltd.
  2. Thomas & Betts Corporation/Elastimold.
  3. 3M; Electrical Products Division.
- B. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class shall be equivalent to that of cable. Include shield ground strap for shielded cable terminations.
  1. Class 1 Terminations: Modular cold-shrink type with stress control, non-tracking tubes, silicon sealing compounds and compression-type connector. 3M Cold Shrink Quick-Term III or e by Raychem or Elastimold.

### **2.3 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Richards Manufacturing Co.
  2. Thomas & Betts Corporation/Elastimold.
- C. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

- D. 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.
- E. 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.
- F. 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.
- G. 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.
- H. Tool Set: Shotgun hot stick with energized terminal indicator, fault-indicator test tool, and carrying case.

## **2.4 ARC-PROOFING MATERIALS**

- A. Description: Fire retardant, providing arc flash protection.
- B. Tape for First Course on Metal Objects: 10-mil-thick, corrosion-protective, moisture-resistant, PVC pipe-wrapping tape.
- C. Arc-Proofing Tape: Fireproof tape, flexible, conformable, intumescent to 0.3 inch thick, and compatible with cable jacket.
- D. Glass-Cloth Tape: Pressure-sensitive adhesive type, 1 inch wide.

## **2.5 SOURCE QUALITY CONTROL**

- A. Test and inspect cables according to ICEA S-97-682 before shipping.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install cables according to IEEE 576.
- B. Proof conduits prior to conductor installation by passing a wire brush mandrel and then a rubber duct swab through the conduit. Separate the wire brush and the rubber swab by 48 to 72 inches on the pull rope.
  - 1. Wire Brush Mandrel: Consists of a length of brush approximately the size of the conduit inner diameter with stiff steel bristles and an eye on each end for attaching the pull ropes. If an obstruction is felt, pull the brush back and forth repeatedly to break up the obstruction.
  - 2. Rubber Duct Swab: Consists of a series of rubber discs approximately the size of the conduit inner diameter on a length of steel cable with an eye on each end for attaching the pull ropes. Pull the rubber duct swab through the duct to extract loose debris from the duct.

- C. 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 does not deteriorate conductor or insulation.
  - 2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips, that do not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.
  - 3. Use pull-in guides, cable feeders, and draw-in protectors as required to protect cables during installation.
  - 4. Do not pull cables with ends unsealed. Seal cable ends with rubber tape.
- 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 26 Section "Hangers and Supports for Electrical Systems."
- F. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit; support cables at intervals adequate to prevent sag.
- G. Install sufficient cable length to remove cable ends under pulling grips. Remove length of conductor damaged during pulling.
- H. Install cable splices only where specifically indicated; use standard kits. Use dead-front separable watertight connectors in manholes and other locations subject to water infiltration.
- I. Install terminations at ends of conductors, and seal 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: At each terminal junction, with one on each terminal.
  - 3. Standoff Insulator: At each terminal junction, with one on each terminal.
- K. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. Arc proof cable accessible within pullboxes, manholes and handholes. 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 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 two layers of 1-inch-wide half-lapped, adhesive, glass-cloth tape at each end of the arc-proof tape.
- L. Seal around cables passing through fire-rated elements according to Division 07 Section "Penetration Firestopping."
- 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 26 Section "Identification for Electrical Systems." Identify circuit number, voltage and phase of each conductor at each splice, termination, pull point, and junction box. Arrange identification so that it is unnecessary to move the cable or conductor to read the identification.

### 3.2 FIELD QUALITY CONTROL

- A. Engage a qualified testing agency to perform tests and inspections and prepared test reports.
- B. Tests and inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Testing shall be done in accordance with manufacturers recommendations. Certify compliance with test parameters.
  - 2. Visual and Mechanical Inspection:
    - a. Compare cable data with Drawings and Specifications.
    - b. Inspect exposed sections of cables for physical damage.
    - c. Inspect bolted electrical connections.
    - d. Inspect compression-applied connectors for correct cable match and indentation.
    - e. Inspect shield grounding, cable supports, and terminations.
    - f. Verify that visible cable bends meet or exceed ICEA and manufacturer's minimum published bending radius.
    - g. Inspect fireproofing in common cable areas.
    - h. If cables are terminated through window-type current transformers, inspect to verify that neutral and ground conductors are correctly placed and that shields are correctly terminated for operation of protective devices.
    - i. Inspect for correct identification and arrangements.
    - j. Inspect cable jacket and insulation condition.
  - 3. Electrical Tests:
    - a. After delivery to Project site, but prior to cable installation, while cable is still on reels, perform initial Very Low Frequency (VLF) test on each cable to be installed.
    - b. After cable installation, but before installation of associated cable terminations, splices and separable connectors, perform a second VLF test on each installed cable.
    - c. When connecting medium-voltage cables into existing circuits, confirm and identify phasing of existing cabling prior to cutting activities required for installation of splices and separable connectors. Reconfirm and identify phasing of existing circuits, and match with new cabling, immediately prior to making final connections.
    - d. After cable installation, and after installation of associated cable terminations, splices and separable connectors, perform a final VLF test on each cable circuit.
      - 1) When testing circuits that include existing medium-voltage cabling, test in accordance with NETA maintenance testing requirements.
    - e. Perform resistance measurements through bolted connections with a low-resistance ohmmeter, if applicable. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    - f. Perform shield continuity test on each cable by ohmmeter method. Resistance in excess of 10 ohms per 1000 feet of cable must be investigated and justified or corrected.
- C. Medium-voltage cables will be considered defective if they do not pass tests and inspections. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

END OF SECTION 26 05 13

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## **SECTION 26 05 19 - LOW-VOLTAGE CONDUCTORS AND CABLES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 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.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated. Submit product data for all items specified under this Section in a single comprehensive Product Data Submittal Package. This Submittal Package shall contain only items specified under, or directly related to, this Section. Submittals that do not include each specified unit or contain incomplete submittal information will be rejected.
- B. Qualification Data: For testing agency.
- C. Field quality-control test reports.

#### **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 NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- 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. Comply with NECA WC 70/ICEA S-95-658.
- E. Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide"

### **PART 2 - PRODUCTS**

#### **2.1 CONDUCTORS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Encore Wire Corporation.
  - 2. Cerro Wire, LLC.
  - 3. General Cable Technologies Corporation.
  - 4. Southwire Company.
- B. Description: Copper conductors, complying with ASTM B-496.
- C. Conductor Insulation:
  - 1. THHN/THWN-2: Comply with UL 83.
  - 2. XHHW-2: Comply with UL 44.



## **2.2 METAL-CLAD CABLE, TYPE MC**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AFC Cable Systems, Inc.
  - 2. Encore Wire Corporation.
  - 3. Southwire Company.
- B. Description: Factory assembly of one or more current-carrying, color-coded, insulated conductors in an overall metallic sheath.
  - 1. Conductors: Soft-drawn copper with THHN/THWN-2 or XHHW-2 insulation.
    - a. Ground Conductor: Insulated, green.
  - 2. Armor: Interlocked aluminum or galvanized steel.
  - 3. Conductor Assembly Covering: Polypropylene tape.
  - 4. UL listed for use in air-handling spaces.
  - 5. Listed for use with UL 1479 – 1, 2 and 3 hour through-penetration firestop systems.
  - 6. Comply with UL 83, 1569, 1581, and 2556 for type MC.

## **2.3 MINERAL-INSULATED CABLE, TYPE MI**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Tyco Thermal Controls/Pyrotenax System 1850.
- B. Description: 2-hour fire-rated cable assembly with solid copper conductors encased in compressed metal oxide within a seamless soft-drawn copper metal sheath, rated 600 V or less.
  - 1. Conductors: Copper, complying with ASTM B 3.
  - 2. Insulation: Highly-compressed magnesium oxide (MgO.)
  - 3. Comply with UL 2196 for 2-hour fire resistive cable.
  - 4. Cable Marking: Conductor size, voltage and UL fire resistive classification number.
  - 5. Direct-Buried Applications: Provide PVC over-jacket.
- C. Mineral-Insulated Cable Terminations and Splices: Compatible with and as recommended by MI cable manufacturer:
  - 1. Conductors No. 10 AWG and Smaller: Tyco Thermal Controls / Pyrotenax Model Pyro-Pak Installation Sheet 545 or approved equivalent.
  - 2. Conductors No. 8 AWG and larger: Tyco Thermal Controls / Pyrotenax Model Quick-Term Installation Sheet 638 or approved equivalent.
  - 3. Cable Splice: Tyco Thermal Controls / Pyrotenax Model Installation Sheet 550 or approved equivalent.
  - 4. Support Hardware: As approved by MI cable manufacturer.

## **2.4 CONNECTORS AND SPLICES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of 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. TE Connectivity Ltd.
  6. Thomas and Betts Corp.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- C. Copper Conductor Terminations: No. 6 AWG and larger copper conductors shall be connected with bolt-on compression connectors by Thomas & Betts (or approved equivalent) sized as required by codes and specifically intended to connect copper wire and cable to panelboards, substations, disconnect switches, and other equipment. Install with hydraulic crimping tool as required by manufacturer's recommendations, to ensure permanent high conductivity connection.
1. Terminations: Thomas & Betts Series 54200 (or approved equivalent) two hole connectors shall be used. Exceptions are as follows:
    - a. Where equipment or device cannot be provided by the manufacturer to accept two hole connectors, T&B Series 54100 (or approved equivalent) single hole connectors with anti-rotation lug or restraint shall be used.
    - b. Where equipment or devices cannot be provided by the manufacturer to accept either two-hole or single-hole compression connectors, set screw type connectors may be submitted. For a set screw connector to be considered by the Engineer, the manufacturer shall provide certification with his/her equipment submittals that his/her equipment will not accommodate the required compression connectors.
  2. Copper to Copper Splices, if allowed, shall be with T&B Series 54500 (or approved equivalent) compression connectors.
  3. Tapping of Copper Conductors shall be with T&B Series 54700 (or approved equivalent) compression taps.
  4. All No. 8 AWG and smaller solid conductors shall be spliced with pre-insulated spring connectors. Connectors shall be Skotch-lok, Buchanan B-Cap or approved equivalent.
  5. For NEC Class 1, 2 or 3 wiring, No. 10 AWG and smaller stranded conductors and terminated with AMP, Inc. "PIDG", UL listed premium grade insulated compression fork connectors or approved equivalent and shall be spliced in a junction box with AMP, Inc. "Plastic-Grip" UL listed, standard grade insulated butt splices or approved equivalent. All motor branch circuit conductors terminating at the motor termination box shall be spliced with compression type connectors.

### **PART 3 - EXECUTION**

#### **3.1 CONDUCTOR MATERIAL APPLICATIONS**

- A. Feeders: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

#### **3.2 CONDUCTOR AND CABLE APPLICATIONS AND WIRING METHODS**

- A. Service Entrance: Type XHHW-2, single conductors in raceway.
- B. Service Entrance, Feeders and Branch Circuits Requiring Fire-Resistance Rating: 2-House fire-rated MI cable.
- C. Underground Feeders and Branch Circuits, including below Slabs-on-Grade: Type XHHW-2, single conductors in raceway.
- D. Exposed Feeders and Branch Circuits, Including in Crawlspace: Type THHN-THWN-2, single conductors in raceway.
- E. Feeders Concealed in Ceilings, Walls and Partitions: Type THHN-THWN-2, single conductors in raceway.

- F. Branch Circuits Concealed in Ceilings, Walls and Partitions: Type THHN-THWN-2, single conductors in raceway; except MC-cable may be used.
- G. Feeders and Branch Circuits Concealed in Concrete within Buildings: Type THHN-THWN-2, single conductors in raceway
- H. Feeders and Branch Circuits Installed below Raised Flooring: Type THHN-THWN-2, single conductors in raceway.
- I. VFC Output Circuits: Type XHHW-2, single conductors in raceway.
- J. Feeders and Branch Circuits Requiring Fire-Resistance Rating: 2-Hour fire-rated MI cable.
- K. Class 1 Control Circuits: Type THHN-THWN-2, in raceway.
- L. Class 2 Control Circuits: Type THHN-THWN-2, in raceway.
- M. Control Circuits Requiring Fire-Resistance Rating: 2-Hour fire-rated MI cable.

### **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. Provide fire-stopping at penetrations of fire-rated construction in accordance with Division 07.
- F. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."
- G. Identify and color-code conductors and cables according to Division 26 Section "Electrical Identification."
- H. MI Cables:
  1. Prior to cable installation, meet with cable manufacturer to review all aspects of the proposed installation. Provide certification from the cable manufacturer as part of the Product Data submittal package that they have reviewed and approved the proposed installation.
  2. Terminations:
    - a. Make field made terminations using approved cable manufacturer termination kits only.
    - b. Complete terminations immediately once started to avoid moisture ingress from surrounding air. Prior to completing each termination, test insulation resistance and follow manufacturer's drying procedures until insulation resistance reaches an acceptable level.
    - c. Use 1/4-inch thick brass connection plates when connecting to ferrous cabinets with single conductor cables. Install connection plates per manufacturer's drawings. Provide supplementary transition enclosure when connecting to equipment that has an enclosure that cannot be modified without voiding its listing or warranty. Connections to enclosures shall be made with manufacturer approved glands.
    - d. Once cable is connected to equipment or transition enclosure, convert to stranded cable and make final connections to equipment lugs.
  3. Sheath Induction Reduction:

- a. When multi-phase circuits have paralleled single conductors, cables shall be run in groups having one of each phase in each group.
  - b. Each set of paralleled conductors shall be separated by at least 2.15 single cable diameters.
  - c. Each group of cables shall be fastened tightly together, at least once between each cable support on horizontal runs and twice on vertical runs, using 1/2-inch wide by 0.030 inch thick stainless steel straps.
4. Exposed and Surface Installations:
- a. Cable may be secured directly to fire-rated building structure using an approved method such as one, or any combination, of the following:
    - 1) Straps: 1/2-inch wide x 3-1/2 inch long by 0.030 thick stainless steel or copper straps. Each strap shall contain two 1/4-inch holes for securing with 3/16-inch by minimum 1-3/4 inch long steel anchors.
    - 2) Steel struts
    - 3) Steel cable tray.
  - b. Distance between cable supports shall not exceed six feet on-center horizontally, or six feet on-center vertically.
5. Embedded Installations:
- a. Cables will be run in the same trifoil or quadfoil configuration as exposed installations.
  - b. Protect against damage during pulling, and during concrete pouring or backfill and tamping.
  - c. Provide protective polymer cable jacket when recommended by cable manufacturer for applicable installation.
6. Wall and Floor Penetrations:
- a. Provide sleeves to protect cable and penetration opening during cable installation.
  - b. Provide approved sealing and fire stopping of all penetrations.
7. Neatly train and lace cable inside boxes, equipment and panelboards.

### **3.4 CONNECTIONS**

- A. 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.
- B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Do not splice power conductors within enclosures of equipment such as switchgear, switchboards, and panelboards.
- D. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

### **3.5 IDENTIFICATION**

- A. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

### **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 07 Section "Penetration Firestopping."

### **3.7 FIELD QUALITY CONTROL**

- A. Engage a qualified testing agency to 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 each service entrance and feeder conductor for compliance with requirements. In addition, test a representative sample of branch circuit 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.
    - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
    - b. Test bolted connections for high resistance using one of the following:
      - 1) A low-resistance ohmmeter.
      - 2) Calibrated torque wrench.
      - 3) Thermographic survey.
    - c. Inspect compression-applied connectors for correct cable match and indentation.
    - d. Inspect for correct identification.
    - e. Inspect cable jacket and condition.
    - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
    - g. Continuity test on each conductor and cable.
    - h. Uniform resistance of parallel conductors.
  - 3. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
    - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    - b. 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.
  - 4. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
- C. Cables will be considered defective if they do not pass tests and inspections. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports to record the following:
  - 1. Procedures used.

2. Results that comply with requirements.
3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 26 05 19

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## **SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 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. Outdoor equipment grounding.
  - 3. Common ground bonding with lightning protection system.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated. Submit product data for all items specified under this Section in a single comprehensive Product Data Submittal Package. This Submittal Package shall contain only items specified under, or directly related to, this Section. Submittals that do not include each specified unit or contain incomplete submittal information will be rejected.
- B. Concealed Component Submittals: Plans, drawn to scale, showing as-built, dimensioned locations of underground and otherwise concealed grounding features and components, including the following:
  - 1. Test wells.
  - 2. Grounding electrodes, including rods and plates.
  - 3. Concrete-encased electrodes.
  - 4. Underground grounding and bonding conductors.
  - 5. Building steel bonding locations.
- C. Field quality-control test reports that include the following:
  - 1. Test procedures used.
  - 2. Test results that comply with the requirements.
  - 3. If applicable, results of failed tests and corrective action taken to achieve test results that comply with the requirements.
- D. Operation and Maintenance Data: In addition to items specified in Division 01 "Operation and Maintenance Data," include the following in emergency, operation and maintenance manuals:
  - 1. Dimensioned drawings showing as-built location of concealed grounding system components.
  - 2. Photo documentation of concealed components.
  - 3. Grounding arrangements and connections for separately derived systems.
  - 4. Instructions for periodic testing and inspection of grounding features at test wells, ground rings, and grounding connections for separately derived systems based on NETA MTS and 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. 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 UL 467 for grounding and bonding materials and equipment.
- C. Testing Agency Qualifications: Certified by NETA.

### **PART 2 - PRODUCTS**

#### **2.1 CONDUCTORS**

- A. Insulated Conductors: Copper or tinned-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 in diameter.
  - 5. Bonding Conductor: No. 4 AWG, stranded conductor.
  - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
  - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

#### **2.2 GROUNDING BUS**

- A. Pre-drilled and factory-cut rectangular bars of annealed bare copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart; minimum 24 inches in length unless otherwise indicated.
- B. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V. Fasteners shall be stainless steel.

#### **2.3 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. Mechanical Connectors: Provide mechanical connectors of the two bolt type, 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.
  - 1. Pipe Connectors: Clamp type, sized for pipe.
  - 2. Materials: The mechanical connector bodies shall be manufactured from high strength, high conductivity cast copper alloy material. Bolts, nuts, washers and lockwashers shall be made of Silicon Bronze and supplied as a part of the connector body and shall be of the two bolted pressure type. Split bolt connector types shall NOT be accepted.
  - 3. The connectors shall meet or exceed UL 467 and be clearly marked with the catalog number, conductor size and manufacturer.
- C. Compression Connectors: Provide compression connectors that meet or exceed the performance requirements of IEEE 837, latest revision. Compression connectors shall be 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.

1. Materials: The compression connectors shall be manufactured from pure wrought copper. The conductivity of this material shall be no less than 99% by IACS standards.
  - a. The installation of the connectors shall be made with a compression tool and die system as recommended by the manufacturer of the connectors.
  - b. The connectors shall be clearly marked with the manufacturer, catalog number, conductor size and the required compressions tool settings.
  - c. Each connector shall be factory filled with an oxide-inhibiting compound.
- D. Welded Connectors: Provide exothermic connections for copper-to-copper and copper-to-steel connections to ground rods, ground buses, ground wires, steel beams, rebar, etc.
  1. The supplier of the equipment shall provide with no additional charge and information or supervision required for the proper installation of the equipment and training of operating personnel
  2. Materials: Conductors spliced with an exothermic welded connection shall be considered as a continuous conductor, as stated in the notes accompanying NEC articles 250.50, 250.64 and IEEE Standard 80 (latest edition).
    - a. Procedures outlined in the Manufacturer's installation instruction shall be followed. Molds shall not be modified during installation in field applications.
    - b. Weld metal shall be a mixture of copper oxide and aluminum. Only one weld metal mixture shall be required for each grounding connection.
    - c. Grounding connections shall be tested and certified in accordance with IEEE 837, UL 486A and UL 467.

## **2.4 GROUNDING ELECTRODES**

- A. Ground Rods: Copper-clad steel; 3/4-inch in diameter by 10 feet long.
- B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.
  1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches long.
  2. Backfill Material: Electrode manufacturer's recommended material.
- C. Ground Plates: 1/4 inch thick, hot-dip galvanized steel, minimum 10-inches by 16-inches.

## **2.5 TEST WELLS**

- A. Sized to accommodate ground rod, grounding conductors, and associated connectors to be housed; minimum 24-inches deep with sand or gravel fill at bottom, flush-buried.
- B. Construction: Heavy-duty, traffic-rated concrete body with open bottom and cover marked "GROUND."
  1. Wells Located in Areas Subject to Deliberate Vehicular Traffic:
    - a. Cylindrical high-density reinforced concrete body rated for deliberate heavy vehicular traffic, minimum 12-inch internal diameter.
    - b. Comply with ASTM C 858 for design and manufacturing processes.
    - c. Bolt-down cast iron cover with recessed hook eyes and cast iron frame ring.
    - d. AASHTO H-20 full-traffic rated assembly.

2. Wells Located in Areas Not Subject to Deliberate Vehicular Traffic:
  - a. Rectangular stackable polymer concrete body rated for non-deliberate heavy vehicular traffic, minimum 12-inch x 12-inch internal dimension.
  - b. Comply with SCTE 77.
  - c. Bolt-down polymer concrete cover with non-skid finish, rated for 20,000 lbs.
  - d. ANSI Tier 15 rated assembly.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Install Products in accordance with manufacturer's instructions.
- B. Mechanical connections shall be accessible for inspection and checking. No insulation shall be installed over mechanical ground connections.
- C. Ground connection surfaces shall be cleaned prior to connections.
- D. Attach grounds permanently before building service is energized.
- E. Provide bonding to meet Regulatory Requirements.
- F. Examine raceway, equipment or area to receive grounding to provide adequate sizes, placement and materials for a complete installation.
- G. Tighten screws and bolts for grounding and bonding 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. Determine numbers and sizes of screw terminals for equipment grounding bars in panelboards and other electrical equipment. Provide screw terminals for active circuits, spares and spaces.

### **3.2 APPLICATIONS**

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger, unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare tinned-copper conductor, No. 4/0 AWG minimum.
  1. Bury at least 24 inches below grade.
- C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
  1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, and 12 inches above finished floor, unless otherwise indicated.
  2. Do not field cut or drill grounding bus.
  3. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
- D. 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.

### **3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS**

- A. Comply with IEEE C2 grounding requirements.

- B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 4/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, non-shrink grout.
- C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

### **3.4 OUTDOOR EQUIPMENT GROUNDING**

- A. Comply with IEEE C2 grounding requirements.
- B. Outdoor Pad-Mounted Electrical Equipment: Install ground ring around the perimeter of concrete pads for outdoor generators, switchgear, transformers, and other electrical equipment. Provide at least two ground rods located at opposite corners of equipment pad and connect to ground ring. Bond ground ring to reinforcing bars of concrete pad in at least two diametrically-opposed locations. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches from the foundation. Ground pad-mounted equipment and noncurrent-carrying metal items associated with equipment by connecting them to underground cable and grounding electrodes.

### **3.5 EQUIPMENT GROUNDING**

- A. Install insulated equipment grounding conductors with all feeders and branch circuits, run within the same raceway as the associated phase conductors.
- B. 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.
- C. Water Heater, Heat-Tracing, and Anti-frost 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.
- D. 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 grounding bus.
  2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
  3. All riser ground wire connections to ground bus shall be exothermic. All equipment ground connections to ground bus shall be mechanical connectors.
  4. Use minimum No. 6 AWG copper conductor, or as indicated on the plans, for communications system grounding conductor.

### **3.6 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 12 to 24 inches 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.
- D. Test Wells: Ground rod driven through bottom of test well. Install at least one test well for each service, unless otherwise indicated. Install at ground rod electrically closest to each service entrance. Set top of test well flush with finished grade or surface.
- 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. 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 apart.
- H. Ground Ring: Install a supplementary grounding electrode consisting of ground rods and wire around the perimeter of the building and connecting to steel columns. When ground rods are not shown on the drawings provide a ground rod at every other column with a maximum spacing of 40'.
  - 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 from building foundation.
  - 3. The perimeter ground wire shall be bonded to each ground rod with an exothermic connection. Provide a No. 4/0 AWG copper ground wire connections from the grounding loop to columns via exothermic connections.
  - 4. Drive ground rods until tops are 24 inches below final grade unless installed in ground test well.
  - 5. Ground rods shall be driven to achieve resistance required by this Section. Provide additional rods as required to achieve specified resistance. Where geological conditions

dictate, ground wire mesh may be provided or additional rods shall be driven in compacted earth areas as require to meet resistance requirement.

6. Connections to ground loop system shall be made with exothermic weld.
  7. Verify that final backfill and compaction has been completed before driving ground rod electrodes.
- I. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
  2. Make connections with clean, bare metal at points of contact.
  3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
  5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- J. Documentation of Concealed Components: Photo document all concealed portions of the grounding and bonding system as they are being installed, including ground rings, grounding electrodes, connections to structure, connections to underground metal piping entering the structure, and connections to electrical and electronic service grounds. Have documentation authenticated by an Owner's representative.
1. Notify Architect at least 48 hours in advance of inspection before concealing grounding system conductors and components.

### **3.7 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
  3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and 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.
  4. 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. Grounding system will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports.
- E. Report and correct measured ground resistances that exceed the following maximum values:
  - 1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 5 ohms.
  - 2. Power and Lighting Equipment or System with Capacity of 500 kVA 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.
  - 5. Electrical Room Ground Busses: 5 ohms.
  - 6. Substations and Pad-Mounted Equipment: 5 ohms.
  - 7. Manhole Grounds: 5 ohms.
  - 8. All Other Systems: 5 ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified maximum values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

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## **SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Steel slotted support systems.
  - 2. Conduit and cable support devices.
  - 3. Support for conductors in vertical conduit.
  - 4. Structural steel for fabricated supports and restraints.
  - 5. Mounting, anchoring, and attachment components.
  - 6. Fabricated metal equipment support assemblies.
  - 7. Construction requirements for concrete bases.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each product type utilized, including the following:
    - a. Slotted support systems, hardware, and accessories.
    - b. Clamps.
    - c. Hangers.
    - d. Sockets.
    - e. Eye nuts.
    - f. Fasteners.
    - g. Anchors.
    - h. Saddles.
    - i. Brackets.
  - 2. Include rated capacities and furnished specialties and accessories.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. For fabrication and installation details for electrical hangers and support systems.
  - 1. Hangers. Include product data for components.
  - 2. Slotted support systems.
  - 3. Equipment supports.
  - 4. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: Signed and sealed by a qualified professional engineer. For hangers and supports for electrical systems.

1. Include design calculations and details of hangers and supports.
- D. Comprehensive Product Data and Shop Drawing Submittal Package: Submit product data and shop drawing information for all items specified under this Section in a single comprehensive Product Data and Shop Drawing Submittal Package. This Submittal Package shall contain only items specified under, or directly related to, this Section. Submittals that do not include each specified unit or contains incomplete submittal information will be rejected.
- E. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  1. Suspended ceiling components.
  2. Ductwork, piping, fittings, and supports.
  3. Structural members to which hangers and supports will be attached.
  4. Size and location of initial access modules for acoustical tile.
- F. Welding certificates.

#### **1.4 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of four times the applied force.

#### **1.5 QUALITY ASSURANCE**

- A. Comply with NFPA 70.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
  1. AWS D1.1/D1.1M.
  2. AWS D1.2/D1.2M.

#### **1.6 COORDINATION**

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

### **PART 2 - PRODUCTS**

#### **2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS**

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c. in at least one surface.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.



- c. ERICO International Corporation.
  - d. GS Metals Corp.
  - e. Thomas & Betts Corporation.
  - f. Unistrut; Tyco International, Ltd.
  - g. Wesanco, Inc.
2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
  3. Material for Channel, Fittings and Accessories: Galvanized steel.
  4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  5. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
  - C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
  - D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
  - E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
  - F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
    1. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
      - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
        - 2) Empire Tool and Manufacturing Co., Inc.
        - 3) Hilti Inc.
        - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        - 5) MKT Fastening, LLC.
    2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
    3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
    4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F 3125/F 3125M, Grade A325.
    5. Toggle Bolts: All-steel springhead type.
    6. Hanger Rods: Threaded steel.

## **2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES**

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

- B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

### **PART 3 - EXECUTION**

#### **3.1 APPLICATION**

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in NECA 1 Table 1 where maximum spacings listed are less than those stated in NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits above suspended ceilings and for fastening raceways to trapeze supports.

#### **3.2 SUPPORT INSTALLATION**

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
  - 6. To Light Steel: Sheet metal screws.
  - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

#### **3.3 INSTALLATION OF FABRICATED METAL SUPPORTS**

- A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### **3.4 CONCRETE BASES**

- A. Construct concrete bases of dimensions indicated but not less than four inches larger in both directions than supported unit, with chamfered edges, and sized so anchors will be a minimum of 10 bolt diameters from edge of the base. Securely anchor concrete bases to floor.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
  - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

### **3.5 PAINTING**

- A. Touchup: Comply with requirements in Division 09 painting Sections. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

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## **SECTION 26 05 33 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.
- B. Related Sections include the following:
  - 1. Division 26 Section "Underground Electrical Pathways" for underground ductbanks, underground feeders, underground branch circuits and underground utility construction.

#### **1.3 DEFINITIONS**

- A. EMT: Electrical metallic tubing.
- B. RSC: Rigid Steel Conduit.
- C. FMC: Flexible metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. RNC: Rigid nonmetallic conduit.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Custom enclosures and cabinets.
- C. Comprehensive Product Data and Shop Drawing Submittal Package: Submit product data and shop drawing information for all items specified under this Section in a single comprehensive Product Data and Shop Drawing Submittal Package. This Submittal Package shall contain only items specified under, or directly related to, this Section. Submittals that do not include each specified unit or contains incomplete submittal information will be rejected.
- D. Coordination Drawings: Conduit routing 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. Structural members in the paths of conduit groups with common supports.
  - 2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

#### **1.5 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AFC Cable Systems, Inc.

2. Alflex Inc.
  3. Allied Tube & Conduit; a Tyco International Ltd. Co.
  4. Anamet Electrical, Inc.; Anaconda Metal Hose.
  5. Electri-Flex Co.
  6. Manhattan/CDT/Cole-Flex.
  7. Maverick Tube Corporation.
  8. O-Z Gedney; a unit of General Signal.
  9. Wheatland Tube Company.
- B. Rigid Steel Conduit: Comply with ANSI C80.1 and UL 6; zinc-coated steel.
- C. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
1. Comply with NEMA RN 1.
  2. Coating Thickness: 0.040 inch, minimum.
- D. EMT: Comply with ANSI C80.3 and UL 797; zinc-coated steel.
- E. FMC: Spiral wrapped zinc-coated steel with insulated throats; comply with UL 1.
- F. LFMC: FMC with PVC jacket; comply UL 360.
- G. 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. RSC: Threaded steel insulated bushings and throats. Locknuts shall be steel/zinc plated.
  3. EMT: Steel or die-cast compression type, with insulated bushings and throats.
- H. Combination Expansion/Deflection Fittings
1. Fittings shall be threaded, hot dipped galvanized malleable iron or steel with internal bonding jumper.
  2. Fittings shall include bonding jumper, insulated bushing and short nipple.
- I. Sealing Fittings
1. Threaded sealing fittings for rigid steel conduits shall be zinc- or cadmium- coated, cast or malleable iron; sealing fittings for aluminum conduit shall be threaded cast aluminum. Fittings that prevent passage of water vapor shall be continuous drain.
  2. Sealing fittings shall be filled with a UL listed sealing compound.
- J. Cable Terminators
1. Provide cable terminator assemblies by O-Z/Gedney or equal.
  2. Assemblies shall have bakelite discs, neoprene rings and sealing compound within a fitting for attachment to raceway.
- K. Joint Compound for Rigid Steel Conduit: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

## **2.2 NONMETALLIC CONDUIT AND TUBING**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFC Cable Systems, Inc.
  2. Anamet Electrical, Inc.; Anaconda Metal Hose.
  3. Arnco Corporation.
  4. CANTEX Inc.
  5. CertainTeed Corp.; Pipe & Plastics Group.
  6. Condux International, Inc.
  7. ElecSYS, Inc.
  8. Electri-Flex Co.
  9. Lamson & Sessions; Carlon Electrical Products.
  10. Manhattan/CDT/Cole-Flex.
  11. RACO; a Hubbell Company.
  12. Thomas & Betts Corporation.
- B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.
1. Solvents and Adhesives: As recommended by conduit manufacturer.

### **2.3 METAL WIREWAYS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-Line, Inc.
  2. Hoffman.
  3. Square D; Schneider Electric.
- B. Description: Sheet metal, complying with UL 870 and sized according to NFPA 70.
1. Indoor, Dry Locations: NEMA 250, Type 1.
  2. Indoor, Wet Locations: NEMA 250, Type 4X, stainless steel.
  3. Outdoor: NEMA 250, Type 4X, stainless steel.
- 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:
1. Indoor, Dry Locations: Screw-cover type.
  2. Indoor, Wet Locations: Flanged-and-gasketed type.
  3. Outdoor: Flanged-and-gasketed type.
- E. Finish: Manufacturer's standard enamel finish for indoor units.

### **2.4 BOXES, ENCLOSURES, AND CABINETS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
  2. EGS/Appleton Electric.
  3. Erickson Electrical Equipment Company.

4. Hoffman.
  5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
  6. O-Z/Gedney; a unit of General Signal.
  7. RACO; a Hubbell Company.
  8. Robroy Industries, Inc.; Enclosure Division.
  9. Spring City Electrical Manufacturing Company.
  10. Thomas & Betts Corporation.
  11. Walker Systems, Inc.; Wiremold Company (The).
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed outdoors or in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Metal Floor Boxes: Cast metal, fully adjustable, rectangular.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron 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: EMT.
  3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  4. Device boxes, Aboveground: Cast metal.
  5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Comply with the following indoor applications, unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
  2. Exposed and Subject to Physical Damage: Rigid steel conduit with cast metal device boxes. Includes raceways in the following locations:

- a. Loading docks.
  - b. Mechanical and electrical rooms.
  - c. Rooftops.
  - d. Janitor's closets.
3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  4. Concealed in Exterior Walls: Rigid steel conduit.
  5. Circuits with Operating Voltage Greater than 600 V: Rigid steel conduit.
  6. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment):
    - a. Dry locations: FMC.
    - b. Wet or Damp locations: LFMC.
  7. Damp or Wet Locations: Rigid steel conduit with cast metal device boxes.
    - a. In Corrosive Environments: Use PVC-coated conduits.
  8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.
- C. Raceways Installed Within Slabs (must be approved by Project Structural Engineer):
1. Feeders, branch circuits and low voltage system: RNC, Type EPC-40-PVC.
  2. Penetrations from concrete slabs and elbows shall be made with galvanized RSC and RSC fittings only.
  3. Installation of raceways in above-grade concrete slabs is prohibited.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

### **3.2 RACEWAY INSTALLATION**

- A. Comply with NECA 1 and NECA 101 for installation requirements applicable to products specified except where requirements on Drawings or in this Article are stricter.
- B. General
1. Check raceway sizes to determine that green equipment ground conductor fits in same raceway with phase and neutral conductors to meet NEC percentage of fill requirements. Increase duct, conduit, tubing and raceway sizes shown or specified as required to accommodate conductors.
  2. Install raceway systems complete before drawing in conductors. Blow through and swab after plaster is finished and dry, and before conductors are installed. Wire shall not be pulled into raceway until building roof and walls are weather-tight.
  3. Install connectors and couplings as recommended by manufacturers. Compression fittings shall not be used with rigid steel conduit. Set screw fittings shall not be used with rigid conduit. Set-screw connectors for EMT shall be tightened to embed screws in conduit.
  4. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200 lb. Tensile strength. Provide at least 12" of slack at each end of pull wire with labels.



5. Galvanized rigid steel conduit installed in corrosive environments shall have all field cut threads coated with an approved, electrically conductive, corrosion resistant compound so that the current carrying ability of the conduit is not compromised.
  6. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab.
  7. Penetrate waterproof walls of structural slabs and foundation walls only where approved by Construction Manager. Submit proposed penetration points, size openings and penetration methods to Construction Manager for approval.
  8. All conduit penetrations through exterior foundation walls shall be sealed. Provide sealing assemblies between conduit and sleeve. Provide cable terminators in conduit for cable seal. Provide appropriate sleeve through wall for conduit required. Assembly shall be tightened to seal out water.
  9. Raceways shall be installed in such a way as to not block exit and equipment service space. Raceway on or adjacent to equipment shall be located to allow free access to all removable panels and equipment service.
  10. Minimum Raceway Size: 3/4-inch trade size.
  11. Keep raceways at least 12 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
  12. Complete raceway installation before starting conductor installation.
- C. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- D. Raceways Installed Underground Below Slab on Grade:
1. Comply with Division 26 Section "Underground Electrical Pathways".
  2. Raceways shall be located on undisturbed earth. Where the earth has been disturbed or is of poor quality excavate a trench to proper subgrade elevation. Place bedding material and compact trench bottom.
  3. Stagger conduit couplings so that couplings on adjacent conduits do not lie in same transverse plane. Provide conduit spacers every five feet.
  4. Elbows transitioning from underground to exposed shall be galvanized RSC. Provide appropriate transition fittings.
  5. Connections between conduits of different types shall be made in approved manner, using adapters and other materials and methods recommended by conduit manufacturers.
  6. Arrange stub-ups so curved portions of bends are not visible above the finished slab.
- E. Install no more than the equivalent of four 90-degree bends in any conduit run except for communications conduits, for which two 90-degree bends are allowed.
- F. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
- G. Raceways Installed Within Slabs
1. If approved by the Project Structural Engineer, branch circuits may be installed within concrete slabs-on-grade. Penetrations from concrete slabs and elbows shall be made with galvanized RSC and RSC fittings only.
  2. Raceways shall not be installed within the floor slabs unless specifically indicated and specifically allowed by the Project Structural Engineer. Refer to Division 3 for additional information.
  3. When raceways are allowed in slabs the following shall apply:

- a. Installation shall conform to ACI (American Concrete Institute) 318, Paragraph 6.3, "Conduits and Pipes Embedded in Concrete".
  - b. Maximum conduit trade size: 1"
  - c. Raceways shall not cross in slab. Raceway may be installed within deep decking flute only.
  - d. Coordinate locations with kitchen island and wall partition and arrange stub-ups so curved portions of bends are not visible above the finished slab.
  - e. Connections between conduits of different types shall be made in approved manner, using adapters and other materials and methods recommended by conduit manufacturers.
  - f. After concrete has set, nonmetallic conduits shall be cleared with mandrel of same size as conduit.
- H. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- I. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.
- J. Terminations
- 1. Raceway shall enter and be secured to cabinet, junction box, pull box or outlet box with locknut outside and bushing inside, or with liquid-tight, threaded, self-locking, cold-weld wedge adapter.
  - 2. Provide additional locknut for rigid conduit and wrench-tighten locknut for EMT or flexible conduit where circuit voltage exceeds 250 V. Locknuts and bushings or self-locking adapters will not be required where conduits are screwed into tapped connections.
  - 3. Vertical conduit runs that terminate in bottoms of wall boxes or cabinets shall be protected from entrance of foreign material before installation of conductors.
  - 4. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.
  - 5. Provide insulated bushings on raceways entering all panels, switchboards, motor controllers, VFDs, etc. and all boxes 12" x 12" and larger to protect conductors.
- K. Raceways for Communications Cable:
- 1. 3/4-Inch Trade Size and Smaller: Install raceways in maximum lengths of 50 feet.
  - 2. 1-Inch Trade Size and Larger: Install raceways in maximum lengths of 75 feet.
  - 3. Install with a maximum of two 90-degree bends or approved 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.
- L. 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. In garages and other areas in which flammable gases or vapors may be present to prevent transmission of gases or vapors through conduits.
  - 3. Where otherwise required by NFPA 70.

M. Expansion/Deflection Fittings

1. Raceway buried or secured rigidly on opposite sides of building expansion joints and long runs of exposed raceway subject to stress due to thermal expansion shall have expansion/deflection fittings. Fittings shall safely deflect and expand to twice distance of structural movement.
2. Provide separate external copper bonding jumper secured with grounding straps on each end of fitting, when integral ground is not provided.
3. Raceways buried in concrete shall cross building expansion joints at right angles; provide expansion fittings as required by manufacturer's instructions. Provide insulated bushings at ends of raceways.
4. Coordinate location of expansion/deflection fittings with the structural and architectural drawings.

N. Flexible Conduit Connections: Use maximum of 36 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

O. 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.

P. Box installation:

1. Determine from the drawings and by actual field conditions, the exact location of each outlet. The outlet locations shall be modified from those shown to accommodate changes in door swings or to clear other interferences that may arise from job construction details, as well as modifications to center them within the room spaces. These modifications shall be made with no change in contract price and shall be a matter of job coordination that gets reflected on the as-built drawings.
2. Check these conditions throughout the entire job and notify the Architect/Engineer or discrepancies, as they may occur, to verify the modifications, if any, before proceeding with the installation.
3. Install boxes in accordance with manufacturer's written instructions, guidelines and the applicable requirements of the NEC, local codes, the National Electrical Contractors Association's "Standard of Installation" and in accordance with recognized industry practices to ensure that products serve the intended function.
4. Coordinate location of boxes with millwork, counters, benches and back-splashes denoted on the Architectural and Electrical Drawings.
5. Coordinate box installation with electrical raceway and cable work, as necessary for proper interface.
6. Coordinate cutting of masonry walls and drywalls to achieve neat openings for boxes.
7. Provide all necessary hardware to secure boxes in place.
8. Sheet metal pull boxes shall be supported adequately to maintain shape. Larger boxes shall have structural steel bracing welded into rigid assembly formed adequately to maintain alignment in shipment and installation. Secure covers with corrosion-resistant screws or bolts.
9. Provide clamps, grids and other appurtenances to secure cables within pull boxes. No cable shall be unsupported for more than 30".
10. Provide cable troughs of special shapes, design and construction required to install, support and enclose feeder cable throughout indicated routing. Troughs shall be as specified above for junction and pull boxes, with reinforcing, insulating supports and clamping for cable installation. Cables shall be continuous throughout troughs, and shall be racked in distributed phase groupings arranged with phase cables surrounding neutral conductors.
11. Location:

- a. Do not install boxes back to back in same wall.
- b. For boxes mounted in exterior walls install insulation behind the box to prevent condensation in box.
- c. Mount boxes flush with wall in all areas unless noted otherwise on the drawings. Boxes in mechanical rooms may be surface mounted where flush mounting is not possible due to construction.
- d. Provide appropriate fire-stopping for outlet backboxes installed in wall cavities of fire rated partitions. Boxes shall not be installed in walls or partitions of staggered stud construction unless a Wall Opening Protective Material is installed with the box in accordance with classification requirements for the protective materials.
- e. Outlet boxes on opposite sides of a wall shall be spaced at least 24-inches apart. In sound-rated partitions, all five side of outlet backboxes must be sealed using moldable sound insulation putty pads such as the following:
  - 1) Kinetics IsoBarrier (for fire-rated partitions) or equal.
  - 2) Kinetics SealTight (non-fire-rated partitions) or equal.
- f. Junction and pull box covers shall be readily accessible. Do not install junction or pull boxes above suspended ceilings except where ceiling is removable or where access panel is provided.
- g. No pull box shall be within 2 feet of another.
- h. Pull boxes connected to concealed conduits shall be mounted with covers flush with finished wall or ceiling. No aluminum pull box shall be embedded in concrete.
- i. Location of boxes shall be verified with Architect prior to rough-in. Refer to architectural details and elevations.

12. Application

- a. Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture.
- b. Junction or pull boxes exposed to rain or in wet locations shall be weatherproof.
- c. Junction or pull boxes used with aluminum conduit shall be metal compatible with aluminum.

**3.3 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 07 Section "Penetration Firestopping."

**3.4 PROTECTION**

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
  - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
  - 2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 26 05 33

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## **SECTION 26 05 43 - UNDERGROUND ELECTRICAL PATHWAYS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased ducts and duct banks.
  - 2. Polymer and pre-cast concrete handholes.
  - 3. Handhole accessories.

#### **1.3 DEFINITION**

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank: Two or more ducts installed in parallel, with or without additional casing materials.
- D. GRC: Galvanized rigid (steel) conduit.
- E. RNC: Rigid nonmetallic conduit.
- F. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of product, including the following:
  - 1. Duct-bank materials, including separators and miscellaneous components.
  - 2. Ducts and conduits and accessories.
  - 3. Accessories for handholes, and boxes.
  - 4. Underground line warning tape.
- B. Shop Drawings for Factory-Fabricated Handholes and Boxes: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
  - 1. Duct entry provisions, including locations and duct sizes.
  - 2. Cover design.
  - 3. Grounding details.
  - 4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
- C. Comprehensive Product Data and Shop Drawing Submittal Package: Submit product data and shop drawing information for all items specified under this Section in a single comprehensive Product Data and Shop Drawing Submittal Package. This Submittal Package shall contain only items specified under, or directly related to, this Section. Submittals that do not include each specified unit or contains incomplete submittal information will be rejected.
- D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
  2. Drawings shall be signed and sealed by a qualified professional engineer.
- E. Qualification Data: For professional engineer and testing agency.
- F. Source quality-control test reports.
- G. Field quality-control test reports.

### **1.5 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- 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 ANSI C2.
- D. Comply with NFPA 70.

### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.
- B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.
- C. Lift and support precast concrete units only at designated lifting or supporting points.

### **1.7 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 Owner, Architect and Construction Manager no fewer than 14 days in advance of proposed interruption of electrical service.
  2. Do not proceed with interruption of electrical service without Owner's, Architect's and Construction Manager's written permission.
- B. Ground Water: Assume ground-water level is at grade level unless a lower water table is noted on Drawings.

### **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.
- B. Furnish cable-support stanchions, arms, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

## **PART 2 - PRODUCTS**

### **2.1 CONDUIT**

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1 and UL 6.
- B. RNC: NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.
1. Solvents and Adhesives: As recommended by conduit manufacturer.

## **2.2 DUCT ACCESSORIES**

- A. Duct Spacers: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacing indicated while supporting ducts during concreting or backfilling.
- B. Underground Line Warning Tape: Comply with underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."

## **2.3 HANDHOLES FOR UNDERGROUND WIRING**

- A. Sized to accommodate conductors and associated connectors to be housed; minimum 24-inches deep with sand or gravel fill at bottom, flush-buried.
- B. Construction: Heavy-duty, traffic-rated concrete body with open bottom and cover marked to indicate applicable service.
  - 1. Handholes Located in Areas Subject to Deliberate Vehicular Traffic:
    - a. Rectangular high-density reinforced concrete body rated for deliberate heavy vehicular traffic, minimum 16-inch by 22-inch internal dimension.
    - b. Comply with ASTM C 858 for design and manufacturing processes.
    - c. Bolt-down galvanized steel checker plate skid-resistant cover with steel frame.
    - d. AASHTO H-20 full-traffic rated assembly.
  - 2. Handholes Located in Areas Not Subject to Deliberate Vehicular Traffic:
    - a. Rectangular stackable polymer concrete body rated for non-deliberate heavy vehicular traffic, minimum 16-inch x 22-inch internal dimension.
    - b. Comply with SCTE 77.
    - c. Bolt-down polymer concrete cover with non-skid finish, rated for 20,000 lbs.
    - d. ANSI Tier 15 rated assembly.
- C. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
  - 1. Cover Finish: Non-skid finish shall have a minimum coefficient of friction of 0.50.
  - 2. Cover Legend: Molded lettering, as indicated for each service.
- D. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

## **2.4 SOURCE QUALITY CONTROL**

- A. Handhole and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
  - 1. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
  - 2. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Coordinate layout and installation of duct, duct bank, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field. Notify Architect if

there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.
- C. Clear and grub vegetation to be removed, and protect vegetation to remain according to Division 31 Section "Site Clearing." Remove and stockpile topsoil for reapplication according to Division 31 Section "Site Clearing."

### **3.2 UNDERGROUND DUCT APPLICATION**

- A. Ducts for Electrical Utility Cables: RNC, NEMA Type EPC-40-PVC in concrete-encased duct bank, unless otherwise indicated or required by utility company. Confirm utility company requirements prior to electrical duct installation.
- B. Ducts for Electrical Cables over 600 V: RNC, NEMA Type EPC-40-PVC in concrete-encased duct bank, unless otherwise indicated.
- C. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC in concrete-encased duct bank, unless otherwise indicated.
- D. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC in direct-buried duct bank, unless otherwise indicated.
- E. Stub-ups: Concrete-encased GRC.

### **3.3 EARTHWORK**

- A. Excavation and Backfill: Comply with Section 31 20 00 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Replace area immediately after backfilling is completed or after construction vehicle traffic in immediate area is complete.
- C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top-soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."
- E. Cut and patch existing pavement in the path of underground duct, duct bank, and underground structures according to "Cutting and Patching" Article in Division 01 Section "Execution."

### **3.4 DUCT AND DUCT-BANK INSTALLATION**

- A. Install duct according to NEMA TCB 2.
- B. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- C. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches, both horizontally and vertically, at other locations, unless otherwise indicated.
- D. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.
- E. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing the duct will not be subject to environmental temperatures above 40 deg C. Where environmental temperatures are calculated to



rise above 40 deg C, and anywhere the duct crosses above an underground steam line, install insulation blankets listed for direct burial to isolate the duct bank from the steam line.

- F. Duct Entrances to Manholes and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches o.c. for 5-inch ducts, and vary proportionately for other duct sizes.
  - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell without reducing duct line slope and without forming a trap in the line.
  - 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line direct-buried duct with calculated expansion of more than 3/4 inch.
  - 3. Grout end bells into structure walls from both sides to provide watertight entrances.
- G. Terminator Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inches o.c. for 4-inch duct, and vary proportionately for other duct sizes.
  - 1. Begin change from regular spacing to terminator spacing 10 feet from the terminator, without reducing duct line slope and without forming a trap in the line.
  - 2. Expansion and Deflection Fittings: Install an expansion and deflection fitting in each duct in the area of disturbed earth adjacent to manhole or handhole. Install an expansion fitting near the center of all straight line duct with calculated expansion of more than 3/4 inch.
- H. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."
- I. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig hydrostatic pressure.
- J. Pulling Cord: Install 100-lbf- test nylon cord in ducts, including spares.
- K. Concrete-Encased Ducts and Duct Bank:
  - 1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches in nominal diameter.
  - 2. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
  - 3. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
  - 4. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
  - 5. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall; 3 inches between ducts for like services, and 12 inches between power and communications ducts.
  - 6. Stub-Ups: Use 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 of concrete.
  - b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment. Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab
7. Reinforcement: Reinforce concrete-encased duct banks with reinforcing rods. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
  8. Concrete Cover: Install a minimum of 3 inches of concrete cover between edge of duct to exterior envelope wall, 2 inches between duct of like services, and 4 inches between power and communications ducts.
  9. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
    - a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
    - b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch reinforcing rod dowels extending 18 inches into concrete on both sides of joint near corners of envelope.
  10. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
  11. Underground Line Warning Tape: Bury conducting warning tape approximately 12 inches below grade above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.
- L. Direct-Buried Duct Banks:
1. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches in nominal diameter.
  2. Depth: Install top of duct bank at least 36 inches below finished grade, unless otherwise indicated.
  3. Set elevation of bottom of duct bank below the frost line.
  4. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
  5. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches between tiers.
  6. Install backfill as specified in Division 02 Section "Earth Moving."
  7. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as

temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 02 Section "Earth Moving."

8. Install ducts with a minimum of 3 inches between ducts for like services and 12 inches between power and signal ducts.
9. 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 of concrete.
  - b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment. Stub-ups shall be minimum 4 inches above finished floor and minimum 3 inches from conduit side to edge of slab
10. Underground Line Warning Tape: Bury conducting warning tape approximately 12 inches below grade above all direct-buried ducts and duct banks. Align tape parallel to and within 3 inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18 inches. Space additional tapes 12 inches apart, horizontally.

### **3.5 INSTALLATION OF HANDHOLES AND BOXES**

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a minimum 6-inch deep level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas and traffic-ways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- D. Install handholes and boxes with bottom below the frost line.
- E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.
- F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

### **3.6 GROUNDING**

- A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding."

### **3.7 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections and prepare test reports:
  1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to duct size minus 1/4 inch. If obstructions are indicated, remove obstructions and retest.
3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

C. Prepare test and inspection reports.

### **3.8 CLEANING**

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

END OF SECTION

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## **SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Identification for raceways.
  - 2. Identification of power and control cables and conductors.
  - 3. Underground-line warning tape.
  - 4. Warning labels and signs.
  - 5. Instruction signs.
  - 6. Equipment identification labels.
  - 7. Miscellaneous identification products.

#### **1.3 SUBMITTALS**

- A. Product Data: For each electrical identification product indicated. Submit product data for all items specified under this Section in a single comprehensive Product Data Submittal Package. This Submittal Package shall contain only items specified under, or directly related to, this Section. Submittals that do not include each specified unit or contain incomplete submittal information will be rejected.
- B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.

#### **1.4 QUALITY ASSURANCE**

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

#### **1.5 COORDINATION**

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, 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.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.
- D. Install identifying devices before installing acoustical ceilings and similar concealment.

## **PART 2 - PRODUCTS**

### **2.1 RACEWAY IDENTIFICATION MATERIALS**

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway and cable size.
- B. Color for Printed Legend:
  - 1. Power Circuits: Black letters on an orange field.
  - 2. Legend: Indicate system or service and voltage, if applicable.
- C. Self-Adhesive Vinyl Labels: Pre-printed, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels: Slit, pre-tensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- E. Snap-Around, Color-Coding Bands: Slit, pre-tensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.
- F. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

### **2.2 CONDUCTOR AND CABLE IDENTIFICATION MATERIALS**

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 milsthick by 1 to 2 incheswide.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or approved equivalent process.
- C. Aluminum Wraparound Marker Labels: Cut from 0.014-inch-thick aluminum sheet, with stamped, embossed, or scribed legend, and fitted with tabs and matching slots for permanently securing around wire or cable jacket or around groups of conductors.
- D. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking nylon tie fastener.
- E. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
  - 1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

### **2.3 UNDERGROUND-LINE WARNING TAPE**

- A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
  - 1. Not less than 6 incheswide by 4 milsthick.
  - 2. Compounded for permanent direct-burial service.
  - 3. Embedded continuous metallic strip or core.
  - 4. Printed legend shall indicate type of underground line.

### **2.4 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 grommets in corners for mounting. Nominal size, 7 by 10 inches.
- D. Metal-Backed, Butyrate Warning Signs: Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch grommets in corners for mounting. Nominal size, 10 by 14 inches.
- E. 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."

## **2.5 INSTRUCTION SIGNS**

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. in. and 1/8 inch thick for larger sizes.
  1. Engraved legend with black letters on white face.
  2. Punched or drilled for mechanical fasteners.
  3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

## **2.6 EQUIPMENT IDENTIFICATION LABELS**

- A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

## **2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS**

- A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
  1. Minimum Width: 3/16 inch.
  2. Tensile Strength: 50 lb, minimum.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black, except where used for color-coding.
- B. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- C. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## **PART 3 - EXECUTION**

### **3.1 APPLICATION**

- A. Raceways and Boxes Containing Cabling over 600 V: Identify by painting red and labeling "High Voltage" every 10 feet along entire length of raceway with orange self-adhesive vinyl label.
- B. Accessible Raceways and Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange self-adhesive vinyl label.
- C. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, self-adhesive vinyl tape applied in bands:
  1. Fire Alarm System: Red.
  2. Fire-Suppression Supervisory and Control System: Red and yellow.
  3. Combined Fire Alarm and Security System: Red and blue.

4. Security System: Blue and yellow.
  5. Mechanical and Electrical Supervisory System: Green and blue.
  6. Telecommunication System: Green and yellow.
  7. Control Wiring: Green and red.
- D. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use metal tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.
- E. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use write-on tags. Identify each ungrounded conductor according to source and circuit number.
- F. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.
- G. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data connections.
1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
  2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
  3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and Operation and Maintenance Manual.
- H. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- I. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Comply with 29 CFR 1910.145 and 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. Switchgear and switchboards.
    - b. Panelboards.
    - c. Uninterruptible power supplies.
    - d. Power transfer switches.
    - e. 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.
- J. Instruction Signs:
1. Operating Instructions: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
  2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer and other emergency operations.



K. 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: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high label; where 2 lines of text are required, use labels 2 inches high.
- b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
- c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

2. Equipment to Be Labeled:

- a. Panelboards, electrical cabinets, and enclosures.
- b. Access doors and panels for concealed electrical items.
- c. Electrical switchgear and switchboards.
- d. Transformers.
- e. Electrical substations.
- f. Emergency system boxes and enclosures.
- g. Motor-control centers.
- h. Disconnect switches.
- i. Enclosed circuit breakers.
- j. Motor starters.
- k. Push-button stations.
- l. Power transfer equipment.
- m. Contactors.
- n. Remote-controlled switches, dimmer modules, and control devices.
- o. Battery inverter units.
- p. Battery racks.
- q. Power-generating units.
- r. Monitoring and control equipment.
- s. Uninterruptible power supply 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 non-adhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.
- F. System Identification Color Banding for Raceways and Cables: Each color band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- G. Color-Coding for Phase and Voltage Level Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
  - 1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
  - 2. Colors for 208Y/120-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
  - 3. Colors for 480Yh/277-V and 480-V Circuits:
    - a. Phase A: Brown.
    - b. Phase B: Orange.
    - c. Phase C: Yellow.
  - 4. Colors for 120/240-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
  - 5. Colors for Neutral Conductors in Raceways Containing Multiple Circuits: White with colored stripe to match color of associated phase conductor.
  - 6. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 12 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
- J. Painted Identification: Prepare surface and apply paint according to painting Sections.

END OF SECTION 26 05 53

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## **SECTION 26 05 73 - ELECTRICAL STUDIES AND SETTINGS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes computer-based, fault-current, overcurrent protective device coordination and arc flash hazard studies. Protective devices shall be set based on results of the protective device coordination study.
- B. Submit final study report prior to receiving final approval of distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Design Engineer for preliminary submittal of sufficient study data to ensure that selection of devices and associated characteristics is satisfactory.
- C. Overcurrent protective devices in distribution equipment associated with Articles 700, 701, and 708 of NFPA 70 are required to be selectively coordinated. Coordination study must include confirmation that equipment provided serving those systems are selectively coordinated in accordance with NFPA 70.

#### **1.3 SUBMITTALS**

- A. Product Data: For computer software program to be used for studies.
- B. Product Certificates: For fault-current-study and coordination-study computer software programs, certifying compliance with IEEE 399; and for arc-flash hazard analysis software, certifying compliance with IEEE 1584 and NFPA 70E.
- C. Qualification Data: For Power Systems Analysis Software Developer and Power System Analysis Specialist.
- D. Electrical Studies and Settings Submittal shall include the following:
  - 1. Table of Contents
  - 2. Executive Summary
  - 3. Calculation methods and tabulations.
  - 4. Coordination-study input data, including completed computer program input data sheets.
  - 5. Utility or Owner correspondence indicating source fault current characteristics.
  - 6. Study and Equipment Evaluation Reports.
  - 7. Short Circuit Report.
  - 8. Coordination-Study Report.
  - 9. Arc Flash Analysis Report
  - 10. One-line diagrams and impedance diagrams.
  - 11. Results of the study.
  - 12. Conclusions and recommendations.

#### **1.4 QUALITY ASSURANCE**

- A. Studies shall be performed using commercially developed and distributed software designed specifically for power system analysis. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Power Systems Analysis Specialist Qualifications: Professional engineer licensed in the state where Project is located, who is experienced in the application of computer software used for

studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices. All elements of power system studies shall be performed under the direct supervision and control of this professional engineer. Final report shall be signed and sealed by Power Systems Analysis Specialist.

- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

## **PART 2 - PRODUCTS**

### **2.1 POWER SYSTEM ANALYSIS SOFTWARE DEVELOPER**

- A. Software Developers: Subject to compliance with requirements, utilize products by one of the following:
  - 1. CGI CYME.
  - 2. EDSA Micro Corporation.
  - 3. ESA Inc.
  - 4. SKM Systems Analysis, Inc.

### **2.2 POWER SYSTEM ANALYSIS SOFTWARE PROGRAM REQUIREMENTS**

- A. Comply with IEEE 242, 399, 551 and 1584
- B. Comply with NFPA 70E.
- C. Analytical features of power system analysis computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. 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 and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
  - 1. Optional Features:
    - a. Arcing faults.
    - b. Simultaneous faults.
    - c. Explicit negative sequence.
    - d. Mutual coupling in zero sequence.

### **2.3 ARC-FLASH WARNING LABELS**

- A. Comply with requirements in Division 26 "Identification for Electrical Systems" for self-adhesive equipment labels. Produce a 3.5-by-5-inch self-adhesive equipment label for each work location included in the analysis.
- B. Label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
  - 1. Location designation.
  - 2. Nominal voltage.
  - 3. Protection boundaries.
    - a. Arc-flash boundary.
    - b. Restricted approach boundary.
    - c. Limited approach boundary.

4. Arc flash PPE category.
  5. Required minimum arc rating of PPE in Cal/cm squared.
  6. Available incident energy.
  7. Working distance.
  8. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. Obtain all information necessary to perform the studies specified herein, including utility system parameters, ratings and settings of existing components, components provided by others, and characteristics of all available sources of fault current.
- B. Contract Documents indicate minimum ratings and requirements for power distribution equipment, motors, motor starting and control equipment, and other devices and components. Specific characteristics and ratings for equipment shall meet or exceed those necessary to comply with the results of the final studies.
  1. Provide devices that meet or exceed required fault-current ratings as determined by studies.
  2. Provide devices as required to achieve or maximize selective coordination.
  3. Modifications to the specified ratings of equipment, that are necessary to comply with the results of the approved Fault-Current and Coordination Studies shall be accomplished without additional expense to Owner.

#### **3.2 EXAMINATION**

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system fault-current, coordination and arc-flash requirements and other conditions affecting performance. Proceed with studies only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and preliminarily approved prior to study may not be used in study.

#### **3.3 POWER SYSTEM DATA**

- A. Gather and tabulate the following input data to support power system studies:
  1. Product Data for overcurrent protective devices specified in other 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: In hard-copy and electronic-copy formats, showing the following:
    - a. Circuit-breaker and fuse-current ratings and types.
    - b. Relays and associated power and current transformer ratings and ratios.
    - c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
    - d. Generator kilovolt amperes, size, voltage, and source impedance.
    - e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
    - f. Busway ampacity and impedance.

- g. 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, showing the following:
- a. Special load considerations, including starting inrush currents and frequent starting and stopping.
  - b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
  - c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
  - d. Generator thermal-damage curve.
  - e. Ratings, types, and settings of utility company's overcurrent protective devices.
  - f. Special overcurrent protective device settings or types stipulated by utility company.
  - g. Time-current-characteristic curves of devices indicated to be coordinated.
  - h. 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.
  - i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
  - j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

### **3.4 FAULT-CURRENT STUDY**

- A. Calculate the maximum available short-circuit current in amperes rms symmetrical at each bus and circuit-breaker position throughout the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
- 1. Switchgear and switchboard buses.
  - 2. Transfer switches.
  - 3. Busway plug-in devices.
  - 4. Motor-control centers.
  - 5. Motor controllers, including variable frequency controllers.
  - 6. Elevator and fire pump controllers.
  - 7. Distribution panelboards.
  - 8. Branch circuit panelboards.
  - 9. Branch circuit load center.
  - 10. Enclosed switches and circuit breakers.
  - 11. Industrial control panels (refer to NEC Article 409.)
  - 12. Air conditioning and refrigeration equipment (refer to NEC Article 440.)
- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. 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 IEEE 141 and IEEE 242.
  - 1. Transformers:
    - a. ANSI C57.12.10.
    - b. ANSI C57.12.22.
    - c. ANSI C57.12.40.
    - d. IEEE C57.12.00.
    - e. IEEE C57.96.
  - 2. Medium-Voltage Circuit Breakers: IEEE C37.010.
  - 3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
  - 4. Low-Voltage Fuses: IEEE C37.46.
- E. Study Report:
  - 1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
- F. Equipment Evaluation Report:
  - 1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
  - 2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
  - 3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

### **3.5 COORDINATION STUDY**

- A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
  - 1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
  - 2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
  - 3. Calculate the maximum and minimum ground-fault currents.
- B. Comply with IEEE 242 recommendations for fault currents and time intervals.
- C. Transformer Primary Overcurrent Protective Devices:
  - 1. Device shall not operate in response to the following:
    - a. Inrush current when first energized.
    - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
    - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
  - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

- D. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
- E. 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. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- F. 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 devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following 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.
- G. Completed data sheets for setting of overcurrent protective devices.

### **3.6 OVERCURRENT PROTECTIVE DEVICE SETTINGS**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative, of electrical distribution equipment being set and adjusted, to assist in setting of overcurrent protective devices within equipment.
- B. Testing: Engage a qualified testing agency to perform the following device settings and to prepare test 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.
    - c. Test overcurrent protective devices to ensure proper operation.
- C. Adjust devices according to recommendations in Chapter 7, "Inspection and Test Procedures," and Tables 10.7 and 10.8 in NETA ATS.



### 3.7 ARC FLASH STUDY

- A. Provide an electrical arc flash hazard analysis on the Facility to determine incident energy, arc flash protection boundaries, and required personal protection equipment (PPE) for all electrical equipment in the facility. The calculations shall comply with NFPA-70E, and IEEE-1584. Labels shall also be provided for equipment as outlined
- B. The purpose of this study is to provide a comprehensive software model of the Facility electrical distribution system, which will document facility compliance with NFPA 70E mandates as described below. This model will serve as an integral part of an ongoing safety program by providing integral work permits and arc flash calculations in compliance with NFPA-70E 2004 Article 130.1(A)(2) for each electrical equipment in the facility.
- C. The analysis and procedures shall comply with the following standards and recommended practices for power system studies.
  - 1. NFPA-70E, 2004 Standard for Electrical Safety in the Workplace
  - 2. IEEE-1584-2002
  - 3. IEEE-242 "Buff Book" Protection and Coordination of Industrial Power Systems
  - 4. IEEE-399 "Brown Book" Power System Analysis
  - 5. IEEE-141 "Red Book" Electric Power Distribution for Industrial Plants
- D. Method
  - 1. A detailed arc flash study shall be performed to determine potential arc flash incident energies, arc flash boundaries, shock hazard boundaries and proper personal protective equipment (PPE) for all energized electrical system equipment tasks for the electrical system studied. The calculations shall comply with NFPA-70E 2004, and IEEE-1584. Bolted short circuit calculations used in the above standards shall comply with ANSI C37.010, C37.13, C37.5, IEEE-141, and IEEE-399. The purpose of this study is to determine arc flash hazards in conformance with NFPA-70E, and to provide a comprehensive software model of the electrical distribution system, which provides integral work permits and arc flash calculations in compliance with NFPA 70E Article 130.1(A)(2) for all equipment in the facility. The software program used in this study shall comply with the above standards. No substitutions in calculation methods will be allowed.
  - 2. The arc flash study shall determine the following results. The results shall be provided in spreadsheet format for each mode and electrical system location to provide easy viewing and comparison. Worst-case arc flash energy levels shall be flagged and the spreadsheet comparison table shall be capable of providing its output directly to high quality vinyl label printers. The calculations shall, as a minimum, include a comparison of both 100% and 85% arcing currents for low voltage equipment for each electrical system configuration or operating mode, indicating worst-case arc flash hazards. The spreadsheet results shall include:
    - a. Equipment name and voltage.
    - b. Upstream equipment device name and ANSI function, i.e. 51/50, etc.
    - c. Equipment type, i.e. switchgear, MCC, Panel, VFD, etc.
    - d. Equipment arc gap.
    - e. Bolted and estimated arcing fault current at the fault point (equipment) in symmetrical amperes. The estimated arcing current should be based on the arcing current equations used.
    - f. Trip time, opening time, and total clearing time (total Arc time) of the protective device.
    - g. Worst-case arc flash boundary for each bus/equipment in the model.

- h. Worst-case arc flash hazard incident energy in cal/cm<sup>2</sup> for each bus/equipment in the model.
  - i. Worst-case personal protective equipment (PPE) for each bus/equipment in the model.
  - j. Working distances for up to five different distances showing items worst-case arc flash boundary, worst-case arc flash hazard incident energy, and worst-case personal protective equipment (PPE) for each distance.
  - k. Indicate "Danger/Hazardous" areas where incident energy is greater than 40 cal/cm<sup>2</sup> and provide recommendations to reduced arc flash energy levels for these areas.
- 3. Flag results where 85% arcing current provided worst-case results.
  - 4. Each mode of operation shall include a detailed write-up indicating areas where incident energy calculations and PPE requirements are higher than calculated in the normal operating mode.
- E. Provide a detailed arc flash analysis report including as a minimum:
- 1. Introduction.
  - 2. Methodology.
  - 3. Information Sources.
  - 4. Key Assumptions.
  - 5. Arc Flash Energy and other consideration for various System Modes of Operation (maintenance mode, bus-tie, co-gen on/off, etc.).
  - 6. Arc Energy at 100% and reduced currents.
  - 7. IEEE 1584-2002 Considerations.
  - 8. Overcurrent Protective Device Changes, Replacements or Setting Changes implemented in study to reduce arc flash hazard exposure.
  - 9. Explanation of Data in Arc Flash Hazard Report Tables.
  - 10. NFPA 70E Information.
  - 11. Shock Hazards with covers removed.
  - 12. Shock Hazard Approach Boundaries.
  - 13. Limited Approach Boundary.
  - 14. Restricted Approach Boundary.
  - 15. Prohibited Approach Boundary.
  - 16. Arc Flash Hazard Boundaries.
  - 17. Results of Arc flash Hazard Analysis for high voltage, medium voltage and low voltage systems, including:
    - a. Working distances.
    - b. Energy Levels.
    - c. PPE Requirements.
    - d. Recommendations to reduce arc flash hazard energy and exposure.
    - e. Arc Flash Hazard Report.
    - f. Electronic Copy in Adobe Acrobat format (6.0 or later)
- F. Provide arch flash hazard labels and install on equipment.

END OF SECTION

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## **SECTION 26 09 23 - LIGHTING CONTROL DEVICES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following lighting control devices:
  - 1. Time clock switches.
  - 2. Outdoor photoelectric switches.
  - 3. Indoor occupancy sensors (non-DRC.)
  - 4. Outdoor motion sensors.
  - 5. Lighting contactors.
  - 6. Emergency shunt relays.
- B. Related Sections include the following:
  - 1. Division 26 Section "Wiring Devices" for wall-box dimmers and manual light switches.

#### **1.3 DEFINITIONS**

- A. LED: Light-emitting diode.
- B. PIR: Passive infrared.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show installation details for occupancy and light-level sensors.
  - 1. Lighting plan showing location, orientation, and coverage area of each sensor.
  - 2. Interconnection diagrams showing field-installed wiring.
- C. Comprehensive Product Data and Shop Drawing Submittal Package: Submit product data and shop drawing information for all items specified under this Section in a single comprehensive Product Data and Shop Drawing Submittal Package. This Submittal Package shall contain only items specified under, or directly related to, this Section. Submittals that do not include each specified unit or contain incomplete submittal information will be rejected.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

#### **1.5 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.

#### **1.6 COORDINATION**

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

## **PART 2 - PRODUCTS**

### **2.1 TIME CLOCK SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Leviton Mfg. Company Inc.
  2. Lithonia Lighting; Acuity Lighting Group, Inc.
  3. Square D; Schneider Electric.
  4. TORK.
  5. Watt Stopper (The).
- B. Electronic Time Clock Switches: Electronic, solid-state programmable units with alphanumeric display; complying with UL 917.
1. Contact Configuration: DPST or as indicated.
  2. Contact Rating: 30-A inductive or resistive, 120/208-240/277-V ac or as indicated.
  3. Programs: 2 channels; each channel shall be individually programmable with 40 on-off operations per week, plus 4 seasonal schedules that modify the basic program, and an annual holiday schedule that overrides the weekly operation on holidays.
  4. Manual Override: ON and OFF override to the next scheduled event using one button for each channel.
  5. Circuitry: Allow connection of a photoelectric relay as substitute for on-off function of a program on selected channels.
  6. Astronomic Time: All channels.
  7. Non-volatile Memory: Permanent schedule retention during power loss.
  8. Battery Backup: For schedules and time clock.
  9. Enclosure: NEMA 1 for indoor units; NEMA 3R for outdoor units.

### **2.2 OUTDOOR PHOTOELECTRIC SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Lithonia Lighting; Acuity Lighting Group, Inc.
  2. Square D; Schneider Electric.
  3. TORK.
  4. Watt Stopper (The).
- B. Description: Solid state, with DPST 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, 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.

### **2.3 INDOOR OCCUPANCY SENSORS (NON-DRC)**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Hubbell Lighting.
  2. Lithonia Lighting; Acuity Lighting Group, Inc.
  3. Sensor Switch, Inc.
  4. 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 30 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 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; 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- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..
  2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
  3. Detection Coverage (Corridor): Detect occupancy within 90 feet when mounted on a 10-foot-high ceiling.
- D. Ultrasonic Type: Ceiling mounting; detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
  2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch- high ceiling.
  3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
  4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch- high ceiling.

5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot- high ceiling in a corridor not wider than 14 feet.
- E. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
  2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
  3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.

## **2.4 LIGHTING CONTACTORS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Allen-Bradley/Rockwell Automation.
  2. ASCO Power Technologies, LP; a division of Emerson Electric Co.
  3. Eaton Electrical Inc.; Cutler-Hammer Products.
  4. GE Industrial Systems; Total Lighting Control.
  5. Hubbell Lighting.
  6. Lithonia Lighting; Acuity Lighting Group, Inc.
  7. Square D; Schneider Electric.
  8. TORK.
  9. Watt Stopper (The).
- B. Description: Electrically operated and mechanically held unless indicated otherwise, combination type with fusible switch, complying with NEMA ICS 2 and UL 508.
1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).
  2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.
  3. Enclosure: Comply with NEMA 250.
  4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.
- C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.
1. Monitoring: On-off status.
  2. Control: On-off operation.

## **2.5 EMERGENCY SHUNT RELAY**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Lighting Control and Design, Inc.

- B. Description: Normally-closed, electrically-held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.
  - 1. Coil Rating: 120 V or as indicated.

## **2.6 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 26 Section "Low-Voltage Conductors and Cables."
- B. Class 1 Control Cable: Multi-conductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage 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.

### **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 26 Section "Low-Voltage Conductors and Cables." Minimum conduit size shall be 3/4 inch.
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and non-power-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 26 Section "Identification for Electrical Systems."
  - 1. Identify controlled circuits in lighting contactors.
  - 2. Identify circuits or luminaires 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.
  - 3. Field Testing Report: Provide detailed field report listing each installed occupancy sensor, listed by room or space installed in, confirming operational check, including sensing zones, auto on-off time delays and all other field-adjustable settings.
- B. Lighting control devices that fail tests and inspections are defective work.



### **3.6 ADJUSTING**

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

### **3.7 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 26 09 23

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## **SECTION 26 09 43 – DIGITAL ROOM CONTROLLER (DRC) BASED LIGHTING CONTROLS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following lighting control devices:
  - 1. Digital room controllers.
  - 2. DRC manual controls (switches and dimmers)
  - 3. DRC occupancy sensors.
  - 4. DRC photosensors.
  - 5. DRC system input/output modules.
  - 6. Emergency shunt relays.
  - 7. Building automation system (BAS) interface
  - 8. Fire alarm system (FAS) interface.
- B. Related Sections include the following:
  - 1. Division 23 Section "Instrumentation and Control for HVAC Systems." for BAS interconnection.
  - 2. Division 28 Section "Digital, Addressable Fire Alarm System" for FAS interconnection.

#### **1.3 DEFINITIONS**

- A. BAS: Building automation system.
- B. Broadcast Command: A command that is received by all devices on a network.
- C. Channel: see Group.
- D. 0-10V Dimming: ANSI E1.3-2001, Entertainment Technology - Lighting Control Systems - 0 to 10V Analog Control Specification.
- E. Fade:
  - 1. Fade Override: The ability to temporarily set fade times to zero for all lighting scenes.
  - 2. Fade Rate: Adjustment steps per second.
  - 3. Fade Time: The time it takes to fade from one setting to another.
- F. FAS: Fire alarm system.
- G. FC: Foot-candle.
- H. Group: One or more luminaires controlled together as a single unit.
- I. LAN: Local Area Network.
- J. LCS: DRC-based Lighting Control System.
- K. LED: Light-Emitting Diode
- L. LCN: Lighting Control Network, a digital communications network that ties individual digital room controllers and other DCR-based lighting control system components together. LCN includes all networking components, wiring, raceways and software required to establish features and functionality specified.

- M. LCSP: Lighting Control System Provider; a single contracting entity and systems integrator providing the DRC-based lighting control system, system warranty and support.
- N. NRTL: Nationally Recognized Testing Laboratory.
- O. PC: Personal Computer using IBM protocols and Microsoft operating system.
- P. PIR: Passive Infrared.
- Q. RCP: Reflected Ceiling Plan
- R. Scene: A lighting state, effect, and/or script.
- S. SOO: Sequence of Operations. Method, process, or procedure for accomplishing a given function or task.
- T. SPD: Surge Protective Device.
- U. Zone: See Group.

#### **1.4 SUBMITTALS**

- A. General: Submittals shall be in searchable PDF electronic format.
- B. Product Data: List of components for lighting control system, including dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes. Include a complete Bill of Materials for each type of product as applicable to include:
  1. User controls, gateways, and other controls and controllers to include dimensions, features, and ratings in accordance with the SOO.
  2. Device covers plates, color, and material.
  3. Operational documentation for software and firmware.
  4. Driver, Ballasts and lamp combinations compatible with dimmer controls.
  5. Control wire and connectors.
  6. Control wire and cable to include color and insulation type.
- C. Delegated Design: The DRC-based lighting controls manufacturer shall design the occupancy sensor and photo sensor layouts to provide a complete volumetric coverage of the spaces in which they are located. Provide proper number of sensors and associated power packs as required to provide full coverage.
- D. Shop Drawings: Provide a complete set of detailed installation drawings specific to this project that include assemblies, schedules, and details as required to fully define the installation, testing, startup, and other elements necessary to create a complete DRC-based lighting control system in accordance with these construction documents to include:
  1. Equipment Outline Drawings: Indicate dimensions, weights, arrangement of components, clearance and access requirements.
  2. Floor Plans: Location, orientation, and coverage area of each sensor, group designations, and other specific design symbols and designations as required to define the installation, location, and configuration of the specific control devices being provided under this contract.
  3. System Riser Diagram: Show connections between components specified in this Section and devices furnished under other Sections. Indicate data communication paths and identify networks, data buses, data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines. Diagram shall be specifically drawn for this project and directly applicable thereto. Generic diagrams are not acceptable.
  4. Daylighting show optimal placement of photo sensor and the proportional relationship between measured light at photo sensor and area(s) being controlled by that light level.
  5. Sample screen shots of monitoring and control software.

- E. Comprehensive Product Data and Shop Drawing Submittal Package: Submit product data and shop drawing information for all items specified under this Section in a single comprehensive Product Data and Shop Drawing Submittal Package. This Submittal Package shall contain only items specified under, or directly related to, this Section. Submittals that do not include each specified unit or contain incomplete submittal information will be rejected.
- F. Manuals and Documentation.
- G. Field quality-control test reports.
- H. Maintenance Data: For DRC-based lighting control system equipment components to include in emergency, operation and maintenance manuals.

## **1.5 MANUALS AND DOCUMENTATION**

- A. Software and Firmware Operational Documentation: Software operating and upgrade manuals.
- B. Record Documents: Drawings showing the actual installed hardware and configuration to include: power circuits, control device identification, schedules of control functions, and controls, and sensors.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements to include:
  1. Event log verifying the performance of all devices generating event messages to include occupancy sensors, control buttons, alarm messages, and any other messages.
  2. Trend data for all daylight zones covering a period of not less than one week and demonstrating performance consistent with the submitted computer models for those spaces.
  3. Trend or event data demonstrating compliance to the occupancy management sequence of operation for all zones or a minimum of three zones randomly chosen by Owner. Data shall include one week of trend data at five minutes intervals for each selected zone to include photo sensor reading, occupancy state, daylight setting, user light setting, and energy use.
  4. Submit reports via pdf electronic files, with supporting data provided as xls files.
  5. Additional documentation for other systems as required demonstrating compliance with the written sequence of operations.
- D. Operation and Maintenance Data: For lighting controls to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 include the following Software manuals.
  1. Adjustments of scene preset controls, fade rates, and fade overrides.
  2. Operation of adjustable zone controls.
  3. Testing and adjusting of emergency lighting and night lighting features.

## **1.6 QUALITY ASSURANCE**

- A. Source Limitation: The LCSP shall provide all DRC-based lighting control components and final commissioning. DRC-based lighting control components shall be by a single vendor.
- B. Lighting control components shall include all operating elements of the lighting control system to include: 0-10V controlled fixtures, occupancy sensors, wall controls, photo sensors, routers, gateways, servers, software, and other devices and software that are an integral part of the lighting control system.
- C. LCSP Qualifications: A firm experienced in sourcing a complete and integrated package of control equipment similar to that indicated for this Project and with a minimum five year record of successful in-service performance on similar projects.
- D. Installer Qualifications: An installer who is trained and recognized by the LCSP in both installation and maintenance of units required for this Project.

- E. Startup Personnel Qualifications: The Installer shall engage specially trained personnel who are directly employed by the LCSP to perform final start-up, configuration, and system testing.
- F. 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.
- G. Comply with 47 CFR, Subparts A and B, for Class A digital devices.
- H. Comply with NFPA 70.
- I. Comply with State and Local energy and electrical codes.

## **1.7 COORDINATION**

- A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Coordinate lighting control components to form an integrated interconnection of compatible components.
  - 1. Match components and interconnections for optimum performance of lighting control functions.
  - 2. Provide all components required to facilitate the described sequences of operations.
- C. Coordinate lighting control components specified in this Section with components specified in other Sections, including the following:
  - 1. Division 26 Section "Lighting."

## **1.8 WARRANTY**

- A. Materials Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Software: Failure of input/output to execute switching or dimming commands.
    - b. Failure of modular relays to operate under manual or software commands.
    - c. Damage of electronic components due to transient voltage surges.
  - 2. Warranty Period: Five years for control components from date of building occupancy.
  - 3. Coverage: Cost to repair or replace malfunctioning parts including labor and excluding consequential damages.
- B. Installation Warranty: Installer shall make timely repairs of problems arising from workmanship, construction document compliance, and defective or failed components.
  - 1. Warranty Period: One year from date of substantial completion.
  - 2. Cost: Labor and materials
- C. On-line Limited System Warranty and Support (Single Point of Responsibility)
  - 1. LCSP shall provide a full system warranty covering the operation of all components provided under this specification and in accordance with construction documents, sequence of operation, and manufacturer's requirements.
  - 2. On-line System Warranty Period: Two years from date of substantial completion. Coverage shall be 24 Hours Per Day, 7 Days Per Week Telephone Technical Support, Excluding Manufacturer Holiday

3. Coverage to include:
  - a. Assist Owner's designated maintenance person to identify and correct problems in accordance with standard warranty.
  - b. Assistance to Owner in operation and configuration of the system.
- D. System Access: Owner to provide VPN or approved equivalent high-speed secure Internet connection to the lighting control domain for duration of the warranty and system support period.

### **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. System Management Software Updates: Two year
  2. Control Module (Gateway): One of each type installed.
  3. Communication Bridge: One for every 10 of each type installed. Furnish at least one of each type
  4. Wall Switches and Dimmers: Equal to two percent of each type installed, but no fewer than twenty.
  5. Graphic Wall Stations: Equal to two percent of each type installed, but no less than one if at least one is provided as part of the Work.
  6. Scene Controllers: Equal to two percent of each type installed, but no less than one if at least one is provided as part of Work.
  7. Occupancy Sensors Equal to two percent of each type installed, but no fewer than twenty.
  8. Daylight Photosensors: Equal to two percent of each type installed, but no fewer than ten.
  9. Power (Relay) Packs: Equal to two percent of each type installed, but no fewer than twenty.
  10. Auxiliary Input/Output Devices: Equal to two percent of each type installed, but no fewer than two.

### **1.10 LCSP SERVICES**

- A. Provide engineering assistance as needed during delivery and installation to assist Installing Contractor.
- B. A qualified factory authorized technician or qualified agent shall provide a sufficient level of inspection prior to energizing the system to assure with a high level of confidence that passive and active lighting system components have been provided and installed in accordance with the contract documents and manufacturer's recommendations whichever is more stringent. Inspections shall include: lighting fixtures, drivers, lamps, ballasts, fixtures wiring, grounding, network wire, connectors, connections, labeling, enclosures, and general workmanship. Printed inspection sheets for a minimum of five of each fixture type and other system elements shall be created, filled in, dated, initialed, and included in the system O&M manual.
- C. A qualified factory authorized technician shall supervise initial turn-on and shall cooperate with the installing Contractor in making any required adjustment or trimming of components to enable the system to function as specified.
- D. As a portion of the final inspection, the technical will demonstrate the system in the presence of the Design Professional, Owner and/or Controls Consultant, as directed, to prove that the system is operating properly as well as providing instruction in the use and Owner's maintenance of the system.
- E. Provide a minimum of four hour sessions (16 hours total) of formal operation and maintenance instruction separate from the demonstration and offered at the convenience of the Owner's schedule in the presence of the Controls Consultant.

- F. Provide a minimum of 40 hours of formal demonstration of the system operation to the commissioning agent. Refer to Division 1 and Part 3 of this specification for extent of scope.

### **1.11 LIGHTING CONTROL CLOSEOUT SERVICES**

- A. The LCSP shall provide an allowance of a minimum of 40 hours of additional programming and configuration with the Lighting Designer, Controls Consultant, and Owner by a qualified factory authorized technician after substantial completion.

## **PART 2 - PRODUCTS**

### **2.1 DRC-BASED LIGHTING CONTROL SYSTEM**

- a. Manufacturers: Subject to compliance with requirements, provide one of the following systems:
  - 1. Acuity nLight.
  - 2. Eaton Greengate.
  - 3. Hubbell NX.
  - 4. WattStopper DLM.
  - 5. Lutron.
- A. Description: Digital room controller based lighting controls with the following features:
  - 1. Manual, time-based and sensor-based (occupancy and daylight) lighting control.
  - 2. The system shall be capable of turning lighting loads on/off as well as dimming lights (if lighting load is capable of being dimmed). Specific dimmers will be capable of "dimming lights to off"
  - 3. System devices shall be networked together, enabling digital communication between devices, and shall be individually addressed.
  - 4. The system architecture shall be capable of enabling stand-alone groups (rooms) of devices to function in some default capacity, even if network connectivity to the system network is lost.
  - 5. The system architecture shall facilitate remote operation via a computer connection.
  - 6. The system shall not require any centrally hardwired switching equipment.
  - 7. Fully wired architecture, wireless devices are unacceptable.

### **2.2 SYSTEM OVERVIEW**

- A. Provide a complete and operational 0-10V lighting control system designed for the control of general purpose and architectural lighting.
- B. The system architecture shall use peer-to-peer communication and distributed logic to provide real-time operation and operational security where the failure of any single component or node shall be locally isolated and not cause the loss of global system functions.
- C. Each Lighting Control Network shall use the LCSP recommended data transmission cable or wire installed per the manufacturer's recommendation.
- D. Provide power boosters as required to maintain network integrity.
- E. System shall have an architecture that is based upon three main concepts; 1) intelligent lighting control devices 2) standalone lighting control zones 3) network backbone for remote or time based operation.
- F. Intelligent lighting control devices shall consist of one or more basic lighting control components; occupancy sensors, photosensor sensors, relays, dimming outputs, manual switch stations, and manual dimming stations. Combining one or more of these components into a single device enclosure should be permissible so as to minimize overall device count of system.

- G. System must interface directly with intelligent LED luminaires such that only CAT-5 cabling is required to interconnect luminaires with control components such as sensors and switches (see Networked LED Luminaire section).
- H. Intelligent lighting control devices shall communicate digitally, require less than 7 mA of current to function (graphic wall stations excluded), and possess RJ-45 style connectors.
- I. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.
- J. Devices within a lighting control zone shall be connected with CAT-5e low voltage cabling in any order.
- K. Lighting control zone shall be capable of automatically configuring itself for default operation without any start-up labor required.
- L. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.
- M. Power for devices within a lighting control zone shall come from either resident devices already present for switching (relay device) or dimming purposes, controls enabled luminaires, or from the network backbone. Standalone “bus power supplies” shall not be required.
- N. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in remotely located devices such as panels) to facilitate system robustness and minimize wiring requirements. Specific applications that require centralized or remote switching shall be capable of being accommodated.
- O. System shall have one or more primary wall mounted network control “gateway” devices that are capable of accessing and controlling connected system devices and linking into an Ethernet LAN.
- P. System shall use “bridge” devices that route communication and distribute power for up to 8 directly connected lighting zones together for purposes of decreasing system wiring requirements.
- Q. System shall have a web-based software management program that enables remote system control, status monitoring, and creation of lighting control schedules and profiles.
- R. Individual lighting zones shall be capable of being segmented into several “local” channels of occupancy, photosensor, and switch functionality for more advanced configurations and sequences of operation.
- S. Devices located in different lighting zones shall be able to communicate occupancy, photosensor (non-dimming), and switch information via the wired backbone.
- T. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day and day-of-week utilization of a space.
- U. Expansion Capability: Adequate to increase the number of control functions in the future by 20 percent. This expansion capability applies as applicable to equipment ratings, housing volumes, spare relays, terminals, number of conductors in control cables, device connected load, and control software.
- V. Line-Voltage Surge Suppression: Factory installed as an integral part of 120vac and 277vac, solid-state control panels and control components or field-mounted surge suppressors that comply with UL 1449 and with IEEE C62.41 for Category A locations.

### **2.3 LIGHTING CONTROL SEQUENCE OF OPERATION**

- A. Refer to Lighting Control Schedule on Drawings for operation and sequences.



## **2.4 LIGHTING CONTROL PROFILES**

- A. Changes to the operation of the system shall be capable of being made in real-time or scheduled via lighting control profiles. These profiles are outlines of settings that direct how a collection of devices function for a defined time period.
- B. Lighting control profiles shall be capable of being created and applied to a single device, zone of devices, or customized group of zones.
- C. All relays and dimming outputs shall be capable of being scheduled to track or ignore information regarding occupancy, daylight, and local user switches via lighting control profiles.
- D. Specific device parameters (e.g. sensor time delay and photosensor set-point) shall be configurable via a lighting control profile.
- E. All lighting control profiles shall be stored on the network control gateway device, with a system backup on the software's host server.
- F. Lighting control profiles shall be capable of being scheduled to run according to the following calendar options: start date/hour/minute, end date/hour/minute, and sunrise/sunset +/- timed offsets.
- G. Sunrise/sunset times shall be automatically derived from location information using an astronomical clock.
- H. Daylight savings time adjustments shall be capable of being performed automatically, if desired.
- I. Lighting control profile schedules shall be capable of being given the following recurrence settings: daily, weekday, weekend, weekly, monthly, and yearly.
- J. Software shall provide a graphical tool for easily viewing scheduled lighting control profiles.

## **2.5 MANAGEMENT SOFTWARE**

- A. Every device parameter (e.g. sensor time delay and photosensor set-point) shall be available and configurable remotely from the software
- B. The following status monitoring information shall be made available from the software for all devices for which it is applicable: current occupancy status, current individual detection statuses, remaining occupancy time delay(s), current photosensor reading, current photosensor inhibiting state, photosensor transitions time remaining, current dim level, device temperature, and device relay state(s).
- C. The following device identification information shall be made available from the software: model number, model description, serial number, manufacturing date code, custom label(s), and parent network device.
- D. A printable network inventory report shall be available via the software.
- E. A printable report detailing all system profiles shall be available via the software.
- F. Software shall require all users to login with a User Name and Password.
- G. Software shall provide at least three permission levels for users.
- H. All sensitive stored information and privileged communication by the software shall be encrypted.
- I. All device firmware and system software updates must be available for automatic download and installation via the internet.
- J. Software shall be capable of managing systems interconnected via a WAN (wide area network)

## **2.6 BAS COMPATIBILITY**

- A. System shall provide a BACnet IP gateway as a downloadable software plug-in to its management software. In addition, BAS connectivity shall be via hardwire components.
- B. BACnet IP hardware shall be capable of supporting up to 1500 total devices across up to 5 total Gateways

- C. BACnet IP connection shall communicate information gathered by networked system to other building management systems.
- D. BACnet IP connection shall translate and forward lighting relay and other select control commands from BAS to networked control devices via profiles stored in the system Gateway. All system devices shall be available for polling for devices status.

## **2.7 SYSTEM ENERGY ANALYSIS**

- A. System shall be capable of reporting lighting system events and performance data back to the management software for display and analysis.
- B. Intuitive graphical screens shall be displayed in order to facilitate simple viewing of system energy performance.
- C. An "Energy Scorecard" shall be display that shows calculated energy savings in dollars, KWHr, or CO2.
- D. Software shall calculate the allocation of energy savings to different control measures (occupancy sensors, photosensors, manual switching, etc).
- E. Energy savings data shall be calculated for the system as a whole or for individual zones.
- F. A time scaled graph showing all relay transitions shall be presented.
- G. A time scaled graph showing a zones occupancy time delay shall be presented
- H. A time scaled graph showing the total light level shall be presented.
- I. User shall be able to customize the baseline run-time hours for a space.
- J. User shall be able to customize up to four time-of-day billing rates and schedules.
- K. Data shall be made available via a .CSV file

## **2.8 CONTROL MODULE (GATEWAY)**

- A. Control module shall be a device that facilitates communication and time-based control of downstream network devices and linking into an Ethernet network.
- B. Devices shall have a user interface that is capable of wall mounting, powered by low voltage, and have a touch screen.
- C. Control device shall have three RJ-45 ports for connection to the graphic touch screen, other backbone devices bridges) or directly to lighting control devices (up to 128 per port).
- D. Device shall automatically detect all devices downstream of it.
- E. Device shall have a standard and astronomical internal time clock.
- F. Device shall have one RJ-45 10/100 BaseT Ethernet connection.
- G. Device shall have a USB port
- H. Each control gateway device shall be capable of linking 1500 devices to the management software, with reduced memory version capable of support up to 400 devices.
- I. Device shall be capable of using a dedicated static or DHCP assigned IP address.

## **2.9 COMMUNICATION BRIDGE**

- A. Device shall surface mount to a standard 4" x 4" square junction box.
- B. Device shall have 8 RJ-45 ports.
- C. Device shall be capable of aggregating communication from multiple lighting control zones for purposes of minimizing backbone wiring requirements back to Control Gateway.
- D. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply or delivered via a CAT-5 cabled connection.

- E. Device shall be capable of redistributing power from its local supply and connect lighting control zones with excess power to lighting control zones with insufficient local power. This architecture also enables loss of power to a particular area to be less impactful on network lighting control system.

#### **2.10 WALL SWITCHES AND DIMMERS**

- A. Devices shall recess into single-gang switch box and fit a standard GFI opening.
- B. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
- C. All devices shall have two RJ-45 ports.
- D. All devices shall provide toggle switch control. Dimming control and low temperature/high humidity operation are available options.
- E. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
- F. Devices with mechanical push-buttons shall provide tactile and LED user feedback.
- G. Devices with mechanical push-buttons shall be made available with custom button labeling
- H. Devices with a single “on” button shall be capable of selecting all possible lighting combinations for a bi-level lighting zone such that the user confusion as to which of two buttons (as is present in multi-button scenarios) controls which load is eliminated.

#### **2.11 GRAPHIC WALL STATIONS**

- A. Device shall have a 3.5” full color touch screen for selecting up to 16 programmable lighting control preset scenes or acting as up to 16 on/off/dim control switches.
- B. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
- C. Device shall enable configuration of all switches, dimmers, and lighting preset scenes via password protected setup screens.
- D. Device shall enable user supplied .jpg screen saver image to be uploaded.
- E. Device shall surface mount to single-gang switch box.
- F. Device shall be powered with Class 2 low voltage supplied locally via a directly wired power supply.
- G. Device shall have a micro-USB style connector for local computer connectivity.
- H. Device shall have two RJ-45 ports for communication

#### **2.12 SCENE CONTROLLERS**

- A. Device shall have two, three, four, or eight buttons for selecting programmable lighting control profiles or acting as on/off switches.
- B. Devices shall be available in four colors (Ivory, White, Light Almond, Gray).
- C. Device shall recess into single-gang switch box and fit a standard GFI opening.
- D. Devices shall provide LED user feedback.
- E. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
- F. All devices shall have two RJ-45 ports.
- G. Device shall be capable of reprogramming other devices in its zone so as to implement user selected lighting scene.
- H. Device shall be capable of selecting a lighting profile be run by the system’s upstream Gateway so as to implement selected lighting profile across multiple zones (and not just its local zone).
- I. Device shall have LEDs indicating current selection.

## **2.13 OCCUPANCY SENSORS**

- A. Occupancy sensors shall sense the presence of human activity within the desired space and fully control the on/off function of the lights.
- B. Sensors shall utilize passive infrared (PIR) technology, which detects occupant motion, to initially turn lights on from an off state, thus preventing false on conditions. Ultrasonic or Microwave based sensing technologies, if deemed necessary by the lighting control vendor, shall also be acceptable.
- C. Sensors shall be available with zero or one integrated dry contact switching relays, capable of switching 1 amp at 24 VAC/VDC (resistive only).
- D. Sensors shall be available with one or two occupancy “poles”, each of which provides a programmable time delay.
- E. Sensors shall be available in multiple lens options which are customized for specific applications.
- F. Communication and Class 2 low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
- G. All sensors shall have two RJ-45 ports or capable of utilizing a splitter.
- H. All sensors shall have the ability to detect when it is not receiving valid communication (via CAT-5 connections) and blink its LED in a pattern to visually indicate of a potential wiring issue
- I. Every sensor parameter shall be available and configurable remotely from the software and locally via the device push-button.
- J. Sensors shall be able to function together with other sensors in order to provide expanded coverage areas by simply daisy-chain wiring together the units with CAT-5 cabling.
- K. Sensors shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements.
- L. Sensors shall have optional features for photosensor/daylight override, dimming control, and low temperature/high humidity operation

## **2.14 DAYLIGHT PHOTOSENSORS**

- A. Photosensors shall provide for an on/off set-point, and a deadband to prevent the artificial light from cycling. Delay shall be incorporated into the photosensor to prevent rapid response to passing clouds.
- B. Photosensor set-point and deadband shall be automatically calibrated through the sensor’s microprocessor by initiating an “Automatic Set-point Programming” procedure. Min and max dim settings as well as set-point may be manually entered.
- C. Deadband setting shall be verified and modified by the sensor automatically every time the lights cycle to accommodate physical changes in the space (i.e., furniture layouts, lamp depreciation, or lamp outages).
- D. Photosensor shall be equipped with an automatic override for 100 hour burn-in of lamps. This feature must be available at any time for lamp replacements. (Note: This function should be performed prior to any dimming of the lamps including the “auto set-point” setting.)
- E. A dual zone option shall be available for On/Off Photosensor, Automatic Dimming Control Photosensor, or Combination units. The second zone shall be capable of being controlled as an “offset” from the primary zone.

## **2.15 POWER (RELAY) PACKS**

- A. Power Packs shall incorporate one Class 1 relay, a 0-10 VDC dimming output, and contribute low voltage power to the rest of the system. Secondary Packs shall incorporate the relay and 0-10 VDC or line voltage dimming output, but shall not be required to contribute system power. Power Supplies shall provide system power only, but are not required to switch line voltage circuit. Auxiliary Relay Packs shall switch low voltage circuits only.

- B. Power Packs shall accept 120 or 277 VAC (or optionally 347 VAC), be plenum rated, and provide Class 2 power to the system.
- C. All devices shall have two RJ-45 ports.
- D. Every Power Pack parameter shall be available and configurable remotely from the software and locally via the device push-button.
- E. Power Pack shall securely mount to junction location through a threaded ½ inch chase nipple or be capable of being secured within a luminaire ballast channel. Plastic clips into junction box shall not be accepted. All Class 1 wiring shall pass through chase nipple into adjacent junction box without any exposure of wire leads. Note: UL Listing under Energy Management or Industrial Control Equipment automatically meets this requirement, whereas Appliance Control Listing does not meet this safety requirement.
- F. When required by local code, Power Pack must install inside standard electrical enclosure and provide UL recognized support to junction box. All Class 1 wiring is to pass through chase nipple into adjacent junction box without any exposure of wire leads.
- G. Power Packs (Secondary) shall be available that provide up to 16 Amp switching of all lighting load types.
- H. Power Packs shall be available that provide up to 5 Amps switching of all lighting load types as well as 0-10 VDC dimming or fluorescent ballasts/LED drivers.
- I. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120 VAC incandescent lighting loads or 120/277 VAC line voltage dimmable fluorescent ballasts (2-wire and 3-wire versions).
- J. Specific Secondary Packs shall be available that provide up to 5 Amps of switching and can dim 120/277 VAC magnetic low voltage transformers.
- K. Specific Secondary Packs shall be available that provide up to 4 Amps of switching and can dim 120 VAC electronic low voltage transformers.
- L. Specific Power/Secondary Packs shall be available that are UL924 listed for switching of Emergency Power circuits.
- M. Specific Secondary Packs shall be available that control louver/damper motors for skylights.
- N. Specific Secondary Packs shall be available that provide a pulse on/pulse off signal for purposes of controlling shade systems via relay inputs.
- O. Power (Secondary) Packs shall be available that provide up to 20 Amps switching of general purposed receptacle (plug-load) control.

## **2.16 AUXILIARY INPUT/OUTPUT DEVICES**

- A. Devices shall be plenum rated and be inline wired, screw mountable, or have an extended chase nipple for mounting to a ½" knockout.
- B. Devices shall have two RJ-45 ports
- C. Communication and low voltage power shall be delivered to each device via standard CAT-5 low voltage cabling with RJ-45 connectors.
- D. Specific I/O devices shall have a dimming control output that can control 0-10 VDC dimmable ballasts or LED drivers by sinking up to 20 mA of current.
- E. Specific I/O devices shall have an input that reads a 0-10 VDC signal from an external device.
- F. Specific I/O devices shall have a switch input that can interface with either a maintained or momentary switch and run a switch event (toggle the lighting load) or run a local/remote control profile.
- G. Specific I/O devices shall sense state of low voltage outdoor photocells and photosensors.
- H. Specific I/O devices shall enable RS-232 communication between lighting control system and Touch Screen based A/V control systems.

- I. Specific I/O devices shall sense momentary and maintained contact closures, and either toggle a connected load after a momentary contact or ramp the load high/low during a maintained contact (stopping when the contact releases).

## **2.17 DIMMING BALLAST, DRIVERS AND SWITCHING MODULES**

- A. Refer to Division 26 Section "Lighting".
- B. The lighting control system shall be fully compatible with the light fixture drivers, ballasts and switching modules.

## **2.18 LIGHTING NETWORK CONDUCTORS AND CABLES**

- A. General:
  - 1. Low-voltage Lighting Control Network wire shall meet the requirements of this specification, the local jurisdiction, or LCSP recommendations, whichever is more stringent.
  - 2. Unless stated otherwise on construction drawings, a Control Network wire pair shall be pulled with each lighting power circuit servicing the 0-10V lighting controls, #16 AWG, stranded copper with THHN insulation or as required to be consistent with NEC Paragraph 300-3(c)(1).
  - 3. Network wire between fixtures shall be Class 2 in accordance with NEC Article 725 and allowed by local jurisdiction. Network wire shall be stranded copper cable, plenum rated with yellow jacket and a minimum size of 18 AWG.
- B. Connectors, Splices, and Taps:
  - 1. High quality gas-tight insulation displacement, wire trap or similar connectors suitable for low voltage, low power, shall be used to splice all Class 1 and Class 2 control wiring.
  - 2. Twist-on wire-nut type connectors are not allowed unless specifically submitted and approved for digital network applications.

## **2.19 ETHERNET LAN**

- A. Provide a building LAN receptacle located at the main system hub. Coordinate work with communications sub-contractor and Owner.
- B. Provide and install patch cables and Ethernet switch hubs in compliance with building LAN requirements and as needed to connect the Lighting System Network to Ethernet LAN.
- C. Provide a TCP/IP modem capable of maintaining a secure Internet connection using VPN or approved equivalent protocol acceptable to Owner.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of LCS.
  - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of DRC-based lighting controls.
  - 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- B. Examine rough-in for lighting control system to verify actual locations of conduit connections before equipment installation.
- C. Examine walls, floors, ceiling, and roofs for suitable conditions where components will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install equipment level, plumb, and at right angles to building in a neat and workmanlike manner.
- B. Anchor to building structural elements and support according to requirements in Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Label all wire and enclosures in accordance with Division 26 "Electrical Identification".

### **3.3 SENSOR INSTALLATION**

- A. Install and aim sensors in locations to achieve not less than 95 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.
- B. It shall be the contractor's responsibility to locate and aim sensors in the correct location required for complete and proper volumetric coverage within the range of coverage of controlled areas per the manufacturer's recommendations. Room shall have 95 to 100 percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective room.
- C. It is the contractor's responsibility to arrange a pre-installation meeting with the manufacturer's factory authorized representative, at the building, to verify placement of sensors and installation criteria.
- D. Proper judgement must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitations or interference of structural components. The contractor shall also provide, at the Owner's facility, the training necessary to familiarize the Owner's personnel with the operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.

### **3.4 WIRING INSTALLATION**

- A. General:
  - 1. Comply with manufacturer's written instructions for wiring installation or this spec whichever is more stringent.
  - 2. All wiring to wall mounted devices in exposed locations shall be installed in EMT.
  - 3. Conductors to Class 2 occupancy sensors, photo-sensors and wall stations shall be installed in EMT, flexible metal conduit or free run cable in accordance with NEC Article 725 for Class 2 circuits.
  - 4. Secure and support cables at intervals not exceeding 5 feet. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
  - 5. Cable supports shall use double wire ties or approved equivalent methods that prevent direct contact between the cable and sharp and /or hard surfaces such as running thread rods, pipe supports and suspended ceiling wires.
  - 6. Cable supports shall be independent of other systems. Cables shall not be secured to ceiling support wires, mechanical ducts or piping or draped across ceilings.
  - 7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
  - 8. Install conductors parallel with walls, a structural members at right angles t.
  - 9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable
  - 10. In the ceiling above the work area wall station, install a 6 foot long cable service loop.

11. In the ceiling at sensors cable shall include at least 6 feet of coiled cable to allow tiles to be relocated.
  12. Pulling Cable: Comply with BICSI ITSIM, monitor cable pull tensions.
- B. Separation from EMI Sources:
1. Comply with BICSI TDMM and ANSI/TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
  2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
  3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
  4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
  5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
  6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points. Separate power-limited and non-power-limited conductors according to equipment manufacturer's written instructions.
- D. Install field-mounted transient voltage suppressors for lighting control devices in Category A locations that do not have integral line-voltage surge protection.
- E. Equipment Grounding: Provide low-impedance "hard" copper earth grounding to drivers, ballasts, fixtures, and control mounting boxes in accordance with driver, ballast, lamp, and control manufacturer's requirements. Floating fixture strike plates and high-impedance "safety grounds" are generally not acceptable and standard UL listed safety grounds may not be sufficient.
- 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.

### 3.5 IDENTIFICATION

- A. Identify components, and power and control wiring in accordance with Division 26 Section "Electrical Identification."



- B. Identify all ceiling mounted controls in blank covered boxes with type of control located in box.
- C. Label each wiring pair within six inches of connection to control network bus supply or termination block. Each control wire pair shall be labeled in accordance with Division 26 Identification section and shall include the electrical power panel name and circuit number with which the wire pair is pulled.

### 3.6 FIELD QUALITY CONTROL AND INITIAL START-UP

- A. At the time of checkout and testing, the Owner's Representative shall be thoroughly instructed on the proper operation of the system. Provide at least two weeks notification to Owner prior to testing
- B. Complete installation and startup checks in accordance with manufacturer's written instructions to include the following:
  - 1. Pre-function:
    - a. Compliance inspection of all materials, controls, and light fixtures
    - b. Activate light fixtures and verify that all fixtures are operating at 100%
    - c. Burn-in fixtures at 100% for 100 hours or per manufacturer's recommendations
    - d. Test that control wiring is free of wire-ground and wire-wire shorts and ac line voltage before connecting to the Bus Supply.
    - e. Perform initial configuration as required by manufacturer to verify proper connection and basic operation of all components.
  - 2. Perform the following field tests and inspections and prepare test reports:
    - a. Complete installation and start-up checks according to manufacturer's written instructions.
    - b. Test for circuit continuity, open, shorts and other tests recommended by the manufacturer.
    - c. Check operation of local control devices.
    - d. Verify that the control system features are operational.
    - e. Test system diagnostics by simulating improper operation of several components selected by Owner/Design Professional.
    - f. After installing sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
    - g. Operational Test: Verify actuation of each sensor and adjust time delays.
    - h. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform Continuity tests of circuits according to manufacturer's written instructions:
    - i. Operational Tests: Set and operate controls at PC workstations 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 the manufacturer. Note response to each test command and operation
    - j. Verify normal operation of each fixture after installation.
    - k. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to backup source and retransfer to normal.
- C. Track testing and functional performance of the system by filling in the following Lighting Control Functional Test Form:

**LIGHTING CONTROL FUNCTIONAL TEST FORM**

Area: \_\_\_\_\_ Date: \_\_\_\_\_ Ref. DWG: \_\_\_\_\_

Function/Mode	Test Method	Pass	Fail	Sign Off			
				EC	MR	CM	CA
<b>Miscellaneous functions.</b>							
All specified functions and features are set up, debugged and fully operable..	Verbal discussion of features.						
Power failure and battery backup and power-up restart functions	Demonstration						
Security and access codes	Demonstration						
Scheduling features fully functional and setup, including holidays.	Observation at computer and via printouts.						
Date and time setting in central computer and verify that field panels read the same.	Demonstration						
<b>Sweep Function</b>							
All of the zones must be verified by turning on at least 25% of the lights in the zone and witnessing an actual sweep off.	Demonstration						
<b>Dimming Functions</b>							
All of the dimmers must be verified by turning on the lights in each area or room and selecting multiple scenes, witnessing an actual change in the lighting levels.	Demonstration						
Verify that delays and ramp times are set and functional so that the speed of change of light fixture output is slow enough to be judged non-bothersome to occupants.	Demonstration						
Verify that the controls and sensors are not easily overridden or disabled by occupants.	Demonstration						
Verify that the occupancy sensor in meeting rooms turns lights off when room is unoccupied for 15 minutes.	Demonstration						
<b>Occupancy Sensor Functions</b>							
Each area with an occupancy sensor shall be monitored to confirm operation of the sensor.	Demonstration						
<b>Miscellaneous</b>							
Verify that the interface to the building computer system is operational.	Demonstration						

Items that do not apply shall be noted with the reasons on this form (N/A = Not applicable, BO = By Others).  
 EC = Electrical Contractor, MR = Manufacturers Representative, CM = Construction Manager, CA = Commissioning Agent.

- D. Remove and replace lighting control devices where test results indicate that they do not comply with specified requirements.
- E. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.
- F. Reports: Prepare written reports of tests, inspections, verifications and observations indicating and interpreting results. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.
- G. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- H. Verify normal operation of each fixture after installation.
- I. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify normal transfer to backup source and retransfer to normal.
- J. If adjustments are made to lighting system, retest to demonstrate compliance with standards.
- K. Internet Connection: Provide a high-speed Internet or approved equivalent communication connection as required by the LCSP for use during system start-up.

### **3.7 LCSP FIELD SERVICE**

- A. Engage a factory-authorized service technician to perform final system configuration and verification to include the following:
  - 1. Verify system compliance and operation in accordance with the design documents
  - 2. Test system diagnostics by simulating improper operation of several components selected by Architect.
  - 3. Test and configure sensors and user controls with final operational settings.
  - 4. Set and operate controls at the system workstation and at monitored and controlled devices to demonstrate their functions and capabilities.
  - 5. Install, configure, and test the Lighting Management System software and graphical interface as required by the Lighting Control sequences of operation.
  - 6. Demonstrate system operation to the Design Professional and Owner as described in Part 1 of this specification.
    - a. Train the Owner's management and maintenance personnel in interpreting and using monitoring displays and in configuring and using software and reports. Train them in troubleshooting, servicing, adjusting, and maintaining equipment.
  - 7. Provide close-out support per Part 1 of this specification.
  - 8. Use the approved final versions of software and maintenance manuals as training aids.
- B. Commissioning Support:
  - 1. Provide support to commissioning process as described in Part 1 of this specification.
  - 2. The LCS shall be commissioned on a floor by floor basis and then finally as an entire system.
  - 3. Final Acceptance of the LCS shall be contingent upon successful commissioning of each floor and the entire system.
  - 4. As the LCS installation is completed on individual floors by the Electrical Installation Contractor, a partial system start up, testing and commissioning plan shall be implemented by the LCS Supplier factory-trained engineer(s).

5. Upon completion of the entire LCS installation by the Electrical Installation Contractor, the system shall then be commissioned by the LCS Supplier as a whole system. The commissioning will be performed upon notification by the Electrical Installation Contractor that the system installation is complete and that all loads have been tested live for continuity and freedom from defects and that all control wiring has been connected and checked for proper continuity. The LCS Supplier shall perform supervisory functions during the Electrical Installation Contractor final checkout.
6. The LCS Supplier shall provide the Owner, Architect and Engineer with ten working days advance notice of the scheduled final commissioning start date.
7. Upon completion of the final system checkout, the LCS Supplier shall demonstrate the functionality of the LCS to the Owner.
8. The LCS Supplier shall demonstrate the operation of the LCS to the Owner. Each lighting sequence shall be fully demonstrated to be in accordance with the Specification.
9. The LCS Supplier shall demonstrate the reliability of the LCS to the Owner. Compliance with the Specification shall be demonstrated over a 30 day test period.
10. The LCS Supplier shall demonstrate the flexibility of the LCS to the Owner. Rezoning of daylight zones and independent zones shall be demonstrated solely with the use of the PC/console. No physical wiring may be moved, added or removed during these demonstrations.
11. The LCS Supplier shall demonstrate the self-diagnostics and self-corrective features of the LCS to the Owner.
12. The LCS Supplier shall demonstrate the emergency lighting and night-light features of the LCS to the Owner. A power outage shall be scheduled during this part of the commissioning program.
13. The LCS Supplier shall demonstrate the occupancy zone integrity of the LCS to the Owner.
14. The LCS Supplier shall demonstrate full reporting capabilities and system refresh rate of 30 seconds or less.
15. During commissioning the following shall be measured to determine system performance:
  - a. Work plane illuminance for various target set points in the open plan areas at any work stations in the daylighting zones as selected by Owner
  - b. Luminance at the interior of the perimeter window wall
  - c. Lighting system energy usage
16. The LCS Supplier shall correlate daylight dimming with natural light levels.
17. System must be demonstrated to perform 90% of the time in accordance with work plane illuminance targets under daylight conditions over a 30 day test period.

### **3.8 OFF-SITE TECHNICAL SUPPORT**

- A. Hardware and Software: Within Two year of the date of Substantial Completion, provide unlimited response to general user questions regarding software and hardware use and operation.
  1. Availability: Eight hours per day, weekdays during normal business hours.
  2. Responder Qualifications: Engineer or technician thoroughly familiar with the Lighting Control System.
- B. Make available to the Owner a support plan to provide off or on-site support for the specific system to include troubleshooting, control, monitoring, and additional training and configuration of the system as requested by the Owner.
- C. Internet or approved equivalent communication channel as required by LCSP shall be provided by Owner.

### **3.9 ADJUSTING**

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. Provide up to six visits to Project during other-than-normal occupancy hours for this purpose.

### **3.10 POST OCCUPANCY EVALUATION**

- A. Post Occupancy Evaluation report one year after Final Acceptance this is for mutual benefit of the Owner and LCSP Supplier to ensure the lighting control system is operating according to the original design intent.
  - 1. Analysis of the lighting energy usage
  - 2. Analysis of the integrity of the zones
  - 3. Analysis of target set points compliance
  - 4. Analysis of lighting sequences and their application in the various spaces
  - 5. Status of emergency lighting

END OF SECTION

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## **SECTION 26 11 16 - SECONDARY UNIT SUBSTATIONS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes indoor secondary unit substations, each consisting of the following:
  - 1. Primary incoming section.
  - 2. Transformer.
  - 3. Secondary distribution section.
- B. Related Sections include the following:
  - 1. Division 23 Sections relating to "Building Automation System" for network interfaces and protocols, and sequences of operation.
  - 2. Division 26 Section "Electrical Studies and Settings" for short-circuit rating of devices and for setting of overcurrent protective devices.
  - 3. Division 26 Section "Medium-Voltage Cables" for requirements of terminating cables in incoming section of substation.

#### **1.3 DEFINITIONS**

- A. NETA ATS: Acceptance Testing Specification.

#### **1.4 SUBMITTALS**

- A. Product Data: Include rated capacities, furnished specialties, and accessories.
- 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. Wiring Diagrams: Power, signal, and control wiring.
  - 2. Dimensioned plans and elevations showing major components and features.
  - 3. One-line diagram.
  - 4. List of materials.
  - 5. Nameplate legends.
  - 6. Size and number of bus bars and current rating for each bus, including mains and branches of phase, neutral, and ground buses.
  - 7. Short-time and short-circuit current ratings of secondary unit substations and components.
  - 8. Ratings of individual protective devices.
  - 9. Time-Current Characteristic Curves: For overcurrent protective devices.
  - 10. Primary Fuses: Submit recommendations and size calculations.
  - 11. BAS Interconnection: Show detailed information regarding network interconnections between substations and building automation system, including coordinated network protocol and necessary communications transmission pathways to be utilized. Clearly document that BAS interconnections have been coordinated.
  - 12. Points List: Provide a comprehensive points list for each component to be interconnected to the BAS. Clearly identify points that will be monitored by the BAS.
- C. Comprehensive Product Data and Shop Drawing Submittal Package: Submit product data and shop drawing information for all items specified under this Section in a single comprehensive Product Data and Shop Drawing Submittal Package. Submittals that do not include each specified unit or contains incomplete submittal information will be rejected.

- D. Coordination Drawings: Floor and 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. Dimensioned layouts, required working clearances, and required areas above and around substations where piping and ducts are prohibited.
  2. Substation layouts and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Include locations of structural supports for structure-supported raceways. Identify field measurements.
  3. Dimensioned concrete bases, outline of secondary unit substation, conduit entries, and grounding locations.
  4. Location of lighting fixtures, sprinkler piping and heads, ducts, and diffusers.
- E. Product Certificates: For secondary unit substations, signed by product manufacturer.
- F. Qualification Data: For testing agency.
- G. Material Test Reports: For secondary unit substations.
- H. Factory test reports.
- I. Field quality-control test reports.
- J. Operation and Maintenance Data: For secondary unit substations and accessories to include in emergency, operation, and maintenance manuals.

### **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. Source Limitations: Obtain secondary unit substation through one source from a single manufacturer.
- C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for secondary unit substations including clearances between substations and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- 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.
- F. Comply with IEEE C37.121.
- G. Comply with NFPA 70.

### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.
- B. Coordinate delivery of secondary unit substations to allow movement into designated space.
- C. Store secondary unit substation components protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.
- D. Handle secondary unit substation components according to manufacturer's written instructions. Use factory-installed lifting provisions.

### **1.7 PROJECT CONDITIONS**

- A. Field Measurements: Indicate measurements on Shop Drawings.

- B. 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 no fewer than 14 days in advance of proposed interruption of electric service.
  - 2. Do not proceed with interruption of electric service without Architect's written permission.
- C. Service Conditions: IEEE C37.121, usual service conditions.

## **1.8 COORDINATION**

- A. Coordinate layout and installation of secondary unit substations and components with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and 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 03.
- C. Coordinate interconnections with the BAS and provide required field support to demonstrate that equipment under this Section is properly reporting at the front-end of the building automation system.

## **1.9 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. Spare fuses: Six of each type and rating of fuse and fusible device used, except for medium-voltage fuses. Include spares for the following:
    - a. Primary disconnect fuses.
    - b. Potential transformer fuses.
    - c. Control power fuses.
  - 2. Spare Indicating Lights: Six of each type installed.
  - 3. Touchup Paint: Two half-pint containers of paint matching enclosure's exterior finish.
  - 4. Primary Switch Contact Lubricant: One container(s).
  - 5. One set of spare mounting gaskets for bushings, handholes, and the gasket between relief cover and flange of pressure relief device.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Provide products by Square D; a brand of Schneider Electric. or approved equivalent.
- B. Indoor Unit Arrangement: Single assembly.
- C. Enclosure: drip-proof, NEMA 250, Type 2.
- D. Enclosure Finish: Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.

### **2.2 INCOMING SECTION**

- A. Primary Incoming Section (for Units shown with Primary Switch): Enclosed, air-interrupter, primary switch.
  - 1. Three pole, single throw, dead front, metal enclosed, with manual stored energy operator, with fuses mounted on a single frame, complying with IEEE C37.20.3.
  - 2. Key interlocking system to prevent fuse access door from being opened unless switch is open. Additionally, interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open.
  - 3. Phase Barriers: Located between blades and fuses of each phase, designed for easy removal, allows visual inspection of switch components when barrier is in place.
  - 4. Window: Permits viewing switch-blade positions when door is closed.



5. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.
  6. Continuous-Current Rating: 600 A.
  7. Short-Circuit Rating:
    - a. Short-time momentary asymmetrical fault rating of 40 kA.
    - b. 3-second symmetrical rating of 25-kA RMS.
    - c. Fault close asymmetrical rating of 40 kA.
  8. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading. Comply with the following:
    - a. Current-Limiting Fuses: Full-range, fast-replaceable, current-limiting type that will operate without explosive noise or expulsion of gas, vapor, or foreign matter from tube. Rated for not less than 50-kA RMS symmetrical current-interrupting capacity.
    - b. Indicator: Integral with each fuse to indicate when it has blown.
    - c. Mounting: Positively held in position with provision for easy removal and replacement from front without special tools.
    - d. Spares: Include three fuses in use and three spare fuses in storage clips in each switch.
- B. Primary Incoming Section (for Units shown without Primary Switch): Terminal assembly with adequate space for incoming-cable terminations and surge arresters, complying with NEMA SG4 and meeting thermal, mechanical, and dielectric requirements specified for the transformer section.
1. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading. Main power fuses shall be located in upstream medium-voltage switchgear. Coordinate required upstream fuse sizes with upstream switchgear vendor.
- C. Surge Arresters: Comply with IEEE C62.11, Distribution class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of any disconnecting device.

### **2.3 DRY-TYPE TRANSFORMER SECTION**

- A. Description: IEEE C57.12.01, IEEE C57.12.51, NEMA ST 20, and dry-type, 2-winding, copper-wound, secondary unit substation transformer.
- B. Enclosure: Indoor, ventilated, vacuum-pressure, impregnated type; with insulation system rated at 220 deg C with an 80 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.
- C. Cooling System: Class AA/FA, air-cooled with forced-air rating, complying with IEEE C57.12.01.
  1. Automatic forced-air cooling system controls, including thermal sensors, fans, control wiring, control power transformer, temperature controller with test switch, power panel with current-limiting fuses, indicating lights, alarm, and alarm silencing relay.
- D. Insulation Materials: IEEE C57.12.01, rated 220 degrees C.
- E. Insulation Temperature Rise: 80 degrees C, maximum rise above 40 degrees C.
- F. Basic Impulse Level: 95 kV.
- G. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.
- H. Low-Sound-Level Requirements: No louder than 6dB below NEMA ST-20 and ANSI/IEEE C57.12.01 standard sound levels when factory tested according to IEEE C57.12.91, and in no case shall sound level exceed 62dB, without fans operating. Submit actual factory sound-level test reports for each unit.
- I. Impedance: Minimum 5.2 percent.
- J. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm. Alarms shall be also be annunciated to the BAS.

## **2.4 SECONDARY DISTRIBUTION SECTION**

- A. Secondary Distribution: Low-voltage switchgear as specified in Division 26 Section "Low-Voltage Switchgear."

## **2.5 IDENTIFICATION DEVICES**

- A. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Electrical Identification."

## **2.6 SOURCE QUALITY CONTROL**

- A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90. Conduct switchgear and switchboard tests according to ANSI C37.51.
- B. Factory Tests: Perform the following factory-certified tests on each secondary unit substation:
  - 1. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
  - 2. Ratios on the rated voltage connection and on tap extreme connections.
  - 3. Polarity and phase relation on the rated voltage connection.
  - 4. No-load loss at rated voltage on the rated voltage connection.
  - 5. Exciting current at rated voltage on the rated voltage connection.
  - 6. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
  - 7. Applied potential.
  - 8. Induced potential.
  - 9. Sound-level.
  - 10. Temperature Test: If a 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 FA rating.
    - a. Temperature test is not required if a record of a temperature test on an essentially duplicate unit is available.
  - 11. Owner reserves the right to witness factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

## **2.7 BAS INTERFACE**

- A. Interconnection to Building Automation System: Each secondary unit substation shall be fully-integrated with the building automation system (BAS) via a communications network connection. Coordinate required interface protocol with BAS supplier and provide BAS supplier with a comprehensive points list to facilitate system programming. Refer to HVAC controls diagrams and sequences for additional information. In addition to required substation monitoring points indicated on HVAC controls diagrams and sequence, BAS shall monitor the following:
  - 1. Primary switch position for each primary switch.
  - 2. Transformer temperature.
  - 3. Transformer fan status.
  - 4. Associated low-voltage distribution section power monitor and electronic trip units.
  - 5. Each alarm and indication point specified.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of work.
- 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 conditions for secondary unit substation installation.
  - D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding" have been met. Maximum ground resistance shall be 5 ohms at secondary unit substation location.
  - E. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install secondary unit substations on concrete bases.
  1. Anchor secondary unit substations to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Sections "Hangers and Supports for Electrical Systems" and "Vibration Controls for Electrical Systems."
  2. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit and 4 inches high.
  3. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "Cast-in-Place Concrete."
  4. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
  5. Install epoxy-coated anchor bolts for anchoring equipment to the concrete base.
  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. Bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.
- B. Vibration Control: Mount substation transformer cores on 2-inch deflection spring mounts with double-layer noise isolation neoprene pads; Mason Industries type SLF or equal. Mount entire transformer on uniformly loaded 0.10 inch deflection waffle or ribbed neoprene pads; Mason Industries type Super-W or equal. Provide 24-inches of flexible conduit at each overhead conduit connection to substations. Provide busway expansion couplings for each busway connection to substations.
- C. 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 26 Section "Electrical Identification."
- B. Operating Instructions: Frame printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of secondary unit substation.

### **3.4 CONNECTIONS**

- A. Ground equipment according to Division 26 Section "Grounding and Bonding."
- B. Connect wiring according to Division 26 Section "Conductors and Cables."

### **3.5 CLEANING**

- A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

### **3.6 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. Perform each visual and mechanical inspection and electrical test according to NETA ATS. Certify compliance with test parameters.
  - 2. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation tested at the specified value or less.
  - 3. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
  - 4. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
    - a. Remove and replace malfunctioning units and retest as specified above.

### **3.7 FOLLOW-UP SERVICE**

- A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:
  - 1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
  - 2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
    - a. Adjust transformer taps.
    - b. Rebalance loads.
    - c. Prepare written request for voltage adjustment by electric utility.
  - 3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
  - 4. Report: Prepare a written report covering monitoring performed and corrective action taken.
- B. Infrared Scanning of Medium-Voltage Switchgear: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.
  - 1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 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 switchgear checked and that describes infrared-scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### **3.8 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems. Refer to Division 01 Section "Demonstration and Training."
- B. Demonstrate that equipment under this Section is properly monitored at the front-end of the building automation system.

END OF SECTION

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## **SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes distribution and buck-boost, dry-type transformers rated 600 V and less, with capacities up to 1000 kVA.

#### **1.3 SUBMITTALS**

- A. Product Data:
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type and size of transformer.
  - 2. Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer.
- B. Shop Drawings:
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.
  - 3. Wiring Diagrams: Power, signal, and control wiring.
- C. Comprehensive Product Data and Shop Drawing Submittal Package: Submit product data and shop drawing information for all items specified under this Section in a single comprehensive Product Data and Shop Drawing Submittal Package. This Submittal Package shall contain only items specified under, or directly related to, this Section. Submittals that do not include each specified unit or contains incomplete submittal information will be rejected.
- D. Qualification Data: For testing agency.
- E. Source quality-control test reports.
- F. Field quality-control test reports.
- G. Output Settings Reports: Record of tap adjustments specified in Part 3.
- H. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

#### **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 NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
- 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. Product Selection for Restricted Space: Drawings indicate maximum dimensions for transformers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

## **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

## **1.6 COORDINATION**

- A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate installation of wall-mounting, structure-hanging and floor-mounting supports with actual transformer provided.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Provide products by Square D; a brand of Schneider Electric. or approved equivalent.

### **2.2 GENERAL TRANSFORMER REQUIREMENTS**

- A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.
  - 1. Transformer cooling shall be by convection only and not rely on fans to achieve full rating.
- B. Comply with NEMA ST 20.
- C. List and label as complying with UL 506 for encapsulated units and UL 1561 for ventilated units.
- D. Cores: Electrical-grade, non-aging silicon steel with high permeability and low hysteresis losses.
- E. Coil Conductors: Continuous windings without splices except for taps.
  - 1. Coil Material: Copper.
  - 2. Internal Coil Connections: Brazed or pressure type.
  - 3. Terminal Connections: Welded or bolted.
- F. Enclosures for Encapsulated Transformers:
  - 1. General: NEMA 250, Type 3R; painted steel with gray enamel finish.
  - 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
- G. Enclosures for Ventilated Transformers:
  - 1. Indoor, Dry Locations: NEMA 250, Type 2, drip-proof; painted steel.
  - 2. Indoor, Wet Locations: NEMA 250, Type 3R, rain-tight; painted steel.
  - 3. Outdoor and in Indoor Mechanical Rooms: NEMA 250, Type 3R, rain-tight; painted steel.
  - 4. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
  - 5. Finish Color for Painted Units: Gray enamel.
- H. Design and Insulation Class:
  - 1. Units Smaller than 15 kVA: Encapsulated design with 180 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
  - 2. Units 15 kVA and Larger: Ventilated design with 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.
- I. Fungus Proofing: Permanent fungicidal treatment for coil and core assemblies for transformers installed in wet or outdoor locations and in indoor kitchen areas.

- J. Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, shall be at least 3 dB less than the maximum average audible sound levels specified in NEMA ST-20.
- K. Allowable Inrush (Energization) Current: Coordinated with associated primary side overcurrent protective device. Transformer inrush current shall be limited to a value that will not cause primary side overcurrent device to trip.
- L. Shipping Restraints: Paint or otherwise color-code bolts, wedges, blocks, and other restraints that are to be removed after installation and before energizing. Use fluorescent colors that are easily identifiable inside the transformer enclosure.

### **2.3 DISTRIBUTION TRANSFORMERS**

- A. Energy Efficiency for Transformers Rated 15 kVA and Larger:
  - 1. Comply with 10 CFR 431 (DOE 2016) efficiency levels.
  - 2. Marked as compliant with DOE 2016 efficiency levels by an NRTL.
- B. Cores: One leg per phase, grounded to enclosure.
- C. Transformer Taps:
  - 1. Units Less than 15 kVA: Two 5 percent taps below rated voltage.
  - 2. Units 15 kVA and Larger: Two 2.5 percent taps above and four 2.5 percent taps below normal full capacity.
- D. Grounding: Provide ground-bar kit or a ground bar installed on the inside of the transformer enclosure.
- E. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for non-sinusoidal load current-handling capability to the degree defined by designated K-factor.
  - 1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor, without exceeding the indicated insulation class in a 40 deg C maximum ambient and a 24-hour average ambient of 30 deg C.
  - 2. Indicate value of K-factor on transformer nameplate.
  - 3. Unit shall comply with requirements of DOE 2016 efficiency levels when tested according to NEMA TP 2 with a K-factor equal to one.
- F. Neutral: Rated 200 percent of full load current for K-factor-rated transformers.
- G. Vibration Isolation: Internal anti-vibration neoprene pads or isolators between core and coil assembly and the transformer enclosure, and between the enclosure and structure being mounted to.

### **2.4 BUCK-BOOST TRANSFORMERS**

- A. Description: Self-cooled, two-winding dry type, rated for continuous duty and with wiring terminals suitable for connection as autotransformer. Transformers shall comply with NEMA ST 1.
  - 1. Impedance at 60Hz:
    - a. Units 10 kVA and Smaller: 2 percent to 5 percent.
    - b. Units Larger than 10 kVA: 4 percent to 6.5 percent.
  - 2. Nameplate Rating: Linear load, 60Hz.
  - 3. Coil Impregnation: Vacuum impregnated with polyester resin.
  - 4. Terminations: Transformer coils shall terminate in mounting pads. Mounting lugs shall be provided on all units up to and including 270 A ratings.
  - 5. Anti-vibration pads or isolators shall be used between the transformer core and coil and the enclosure, and between the enclosure and structure being mounted to.

6. Ground core and coil assembly to enclosure with a flexible copper grounding strap or approved equivalent.

## **2.5 IDENTIFICATION DEVICES**

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution and buck-boost transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

## **2.6 SOURCE QUALITY CONTROL**

- A. Test and inspect transformers according to IEEE C57.12.01 and IEEE C57.12.91.
  1. Resistance measurements of all windings at rated voltage connections and at all tap connections.
  2. Ratio tests at rated voltage connections and at all tap connections.
  3. Phase relation and polarity tests at rated voltage connections.
  4. No load losses, and excitation current and rated voltage at rated voltage connections.
  5. Impedance and load losses at rated current and rated frequency at rated voltage connections.
  6. Applied and induced tensile tests.
  7. Regulation and efficiency at rated load and voltage.
  8. Insulation-Resistance Tests:
    - a. High-voltage to ground.
    - b. Low-voltage to ground.
    - c. High-voltage to low-voltage.
  9. Temperature tests.
- B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
- B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
- 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 requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Environment: Enclosures shall be rated for the environment in which they are located. Covers for NEMA 250, Type 4X enclosures shall not cause accessibility problems.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install transformers level and plumb.
- B. Install transformers in accordance with manufacturer's written instructions, seismic codes applicable to Project, and requirements in Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Install wall-mounting transformers with wall brackets fabricated by transformer manufacturer.



- D. Install floor-mounted transformers on concrete bases. Coordinate size and location of concrete bases with actual transformer provided.
- E. Secure covers to enclosure and tighten all bolts to manufacturer-recommended torques to reduce noise generation.
- F. Remove shipping bolts, blocking, and wedges.

### **3.3 VIBRATION CONTROL**

- A. Mount transformer on properly-loaded vibration isolation elastomeric pads or isolators. Ensure through bolts are isolated through elastomeric grommets. Attached electrical connections via flexible conduits. Do not rigidly attach any part of transformer to adjacent walls or structure.
- B. Trapeze-Mounts for Hung Transformers: Construct trapeze mounts for hung transformers using appropriately-sized steel unistrut channel bases attached to structural ceiling using 3/4-inch minimum diameter threaded rods, each with an appropriately sized in-line neoprene or spring isolator. Threaded rods shall be anchored to structure in a manner acceptable to the Project Structural Engineer.
- C. Provide flexible connections at all conduit and conductor terminations and supports to eliminate sound and vibration transmission to the building structure.

### **3.4 CONNECTIONS**

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage 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-486B.

### **3.5 FIELD QUALITY CONTROL**

- A. Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
  - 1. After installing equipment, perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification (ATS) for dry-type, air-cooled, low-voltage transformers. Certify compliance with test parameters.
  - 2. Small (Up to 167-kVA Single-Phase or 500-kVA Three-Phase) Dry-Type Transformer Field Tests:
    - a. Visual and Mechanical Inspection.
      - 1) Inspect physical and mechanical condition.
      - 2) Inspect anchorage, alignment, and grounding.
      - 3) Verify that resilient mounts are free and that any shipping brackets have been removed.
      - 4) Verify the unit is clean.
      - 5) Perform specific inspections and mechanical tests recommended by manufacturer.
      - 6) Verify that as-left tap connections are as specified.
      - 7) Verify the presence of surge arresters and that their ratings are as specified.
    - b. Electrical Tests:
      - 1) Measure resistance at each winding, tap, and bolted connection.
      - 2) Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the

- absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
- 3) Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
  - 4) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
3. Large (Larger Than 167-kVA Single Phase or 500-kVA Three Phase) Dry-Type Transformer Field Tests:
- a. Visual and Mechanical Inspection:
    - 1) Inspect physical and mechanical condition.
    - 2) Inspect anchorage, alignment, and grounding.
    - 3) Verify that resilient mounts are free and that any shipping brackets have been removed.
    - 4) Verify the unit is clean.
    - 5) Perform specific inspections and mechanical tests recommended by manufacturer.
    - 6) Verify that as-left tap connections are as specified.
    - 7) Verify the presence of surge arresters and that their ratings are as specified.
  - b. Electrical Tests:
    - 1) Measure resistance at each winding, tap, and bolted connection.
    - 2) Perform insulation-resistance tests winding-to-winding and each winding-to-ground. Apply voltage according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.5. Calculate polarization index: the value of the index shall not be less than 1.0.
    - 3) Perform power-factor or dissipation-factor tests on all windings.
    - 4) Perform turns-ratio tests at all tap positions. Test results shall not deviate by more than one-half percent from either the adjacent coils or the calculated ratio. If test fails, replace the transformer.
    - 5) Perform an excitation-current test on each phase.
    - 6) Perform an applied voltage test on all high- and low-voltage windings to ground. See IEEE C57.12.91, Sections 10.2 and 10.9.
    - 7) Verify correct secondary voltage, phase-to-phase and phase-to-neutral, after energization and prior to loading.
- C. Remove and replace malfunctioning units and retest as specified above. Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- D. Infrared Scanning: Two months after Substantial Completion, perform an infrared scan of transformer connections.
1. Use an infrared-scanning device designed to measure temperature or detect significant deviations from normal values. Provide documentation of device calibration.
  2. Perform 2 follow-up infrared scans of transformers, one at four months and the other at 11 months after Substantial Completion.

3. 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.
- E. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

### **3.6 ADJUSTING**

- A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 5 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.

### **3.7 CLEANING**

- A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 26 22 00

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## **SECTION 26 23 00 - LOW-VOLTAGE SWITCHGEAR**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes metal-enclosed, low-voltage power circuit-breaker switchgear rated 1000 V and less for use in ac systems.
- B. Related Sections include the following:
  - 1. Division 23 Sections relating to "Building Automation System" for network interfaces and protocols.

#### **1.3 DEFINITIONS**

- A. ATS: Acceptance Testing Service.
- B. BAS: Building Automation System.
- C. GFCI: Ground-fault circuit interrupter.
- D. Inominal: Nominal discharge current.
- E. MCOV: Maximum continuous operating voltage.
- F. OCPD: Overcurrent protective device.
- G. SCCR: Short-circuit current rating.
- H. SPD: Surge-protective device.
- I. VPR: Voltage protection rating.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of switchgear, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each type of switchgear and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment.
  - 2. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
  - 3. Wiring Diagrams: Power, signal, and control wiring.

4. Tabulation of installed devices with features and ratings.
  5. Enclosure types and details.
  6. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
  7. Current rating of buses.
  8. Short-time and short-circuit current rating of switchgear assembly.
  9. Nameplate legends.
  10. Mimic-bus diagram.
  11. Utility company's metering provisions with indication of approval by utility company.
  12. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  13. Control system components, wiring diagrams, and operation sequences.
  14. BAS Interconnection: Show detailed information regarding network interconnections between switchgear units and building automation system, including coordinated network protocol and necessary communications transmission pathways to be utilized. Clearly document that BAS interconnections have been coordinated.
  15. Points List: Provide a comprehensive points list for each component to be interconnected to the BAS. Clearly identify points that will be monitored by the BAS.
- C. Comprehensive Product Data and Shop Drawing Submittal Package: Submit product data and shop drawing information for all items specified under this Section in a single comprehensive Product Data and Shop Drawing Submittal Package. Submittals that do not include each specified unit or contain incomplete submittal information will be rejected.
- D. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- E. Qualification Data: For testing agency.
- F. Field quality-control test reports.
- G. Updated mimic-bus diagram reflecting field changes after final switchgear load connections have been made, for record.
- H. Operation and Maintenance Data: For switchgear and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  2. 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. Source Limitations: Obtain switchgear through one source from a single manufacturer.

- 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 NFPA 70.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver switchgear in sections of lengths that can be moved past obstructions in delivery path.
- B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.

## **1.7 PROJECT CONDITIONS**

- A. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
  - 1. Ambient Temperature: Not exceeding 40 deg C.
  - 2. Altitude: Not exceeding 6600 feet.

## **1.8 COORDINATION**

- A. Coordinate layout and installation of switchgear and components with other construction that penetrates ceilings or is supported by them, including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- C. Coordinate interconnections with the BAS and provide required field support to demonstrate that equipment under this Section is properly reporting at the front-end of the building automation system.

## **1.9 WARRANTY**

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace switchgear enclosures, buswork, overcurrent protective devices, accessories, and factory installed interconnection wiring that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Three years from date of Substantial Completion.
- B. Manufacturer's Warranty: Manufacturer's agrees to repair or replace surge protection devices that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

## **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: Six of each type and rating used. Include spares for potential transformer fuses, control power fuses, and fuses and fusible devices for fused circuit breakers.
  - 2. Indicating Lights: Six of each type installed.
  - 3. Touchup Paint: 3 containers of paint matching enclosure finish, each 0.5 pint.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by Square D; a brand of Schneider Electric or approved equivalent.

### **2.2 DESCRIPTION**

- A. Metal-enclosed, low-voltage switchgear with draw-out power circuit breakers, with accessories and metering components; factory assembled and tested and complying with the following:
  - 1. 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.
  - 2. IEEE C37.13, Low-Voltage AC Power Circuit Breakers Used In Enclosures.
  - 3. IEEE C37.20.1, Metal-Enclosed Low Voltage Power Circuit Breaker Switchgear.
  - 4. UL 1066, Low Voltage AC and DC Power Circuit Breakers Used in Enclosures.
  - 5. UL 1558, Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear.
  - 6. Listed and labeled for use as service entrance equipment.

### **2.3 SWITCHGEAR STRUCTURE**

- A. Indoor Enclosure: Steel, NEMA 250, Type 2 drip-proof.
- B. Finish: IEEE C37.20.1, manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.
- C. Section barriers between main and tie circuit-breaker compartments shall be extended to rear of section.
- D. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker.
- E. Fabricate enclosure with removable, hinged, rear cover panels to allow access to rear interior of switchgear.
- F. Switchgear Bus:
  - 1. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.
  - 2. Main Phase Bus: Uniform capacity the entire length of assembly.

3. Neutral Bus: 100 percent of phase-bus ampacity, unless otherwise indicated. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
4. Vertical Section Bus Size: Fully rated, equal to horizontal bus rated current.
5. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
6. Use copper for connecting circuit-breaker line to copper bus.
7. Contact Surfaces of Buses: Silver plated.
8. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
9. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 1/4 by 2 inches.
10. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
11. Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
12. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch copper bus, arranged to connect neutral bus to ground bus.
13. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.

G. Circuit-Breaker Compartment:

1. Draw-out Features: Circuit-breaker mounting assembly equipped with hinged outer doors and a racking mechanism to position circuit breaker and hold it rigidly in connected, test, disconnected, and withdrawn positions. Include the following features:
  - a. Provide circuit-breaker racking system with positive stops at connected, test, disconnected, and withdrawn positions.
  - b. Interlocks: Prevent racking of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
  - c. Circuit-Breaker Positioning: Permit the racking of an open circuit breaker to or from connected, test, and disconnected positions only when the compartment door is closed unless live parts are covered by a full dead-front shield. Permit manual withdrawal of an open circuit breaker to a position for removal from the structure. When compartment door is open, status for connection devices for different positions includes the following:
    - 1) Test Position: Primary disconnects disengaged, and secondary disconnect devices and ground contact engaged.
    - 2) Disconnected Position: Primary and secondary devices and ground contact disengaged.
  - d. Primary Disconnect: Mount on the stationary part of the compartment. Disconnect shall consist of a set of contacts extending to the rear through an insulating support barrier, and of corresponding moving finger contacts on the power circuit-breaker studs, which engage in only the connected position. Assembly shall provide multiple silver-to-silver full floating, spring-loaded, high-pressure-point contacts with uniform pressure on each finger. Load studs shall connect to bus extensions that terminate in solderless terminals in the rear cable compartment.
  - e. Secondary Disconnect: Floating terminals mounted on the stationary part of the compartment that engage mating contacts at the front of breaker.
  - f. Provide a verification of positive ground contact between the circuit breaker and its compartment when the accessory cover is removed while the circuit breaker is in connected, test, disconnected, and withdrawn positions.
  - g. Place 2400-A frame and larger circuit breakers at the bottom of switchgear.

H. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following where required:



1. Utility metering compartment that complies with utility company requirements.
2. Incoming line pull sections.
3. Bus transition sections.
4. Hinged front panels for access to metering, accessory, and blank compartments.
5. Instrument compartments when additional space is required for metering and instrumentation. Allow for routing of instrumentation, control and communications wires and cables.

## 2.4 COMPONENTS

- A. Instrument Transformers: Comply with IEEE C57.13.
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: IEEE C57.13; 5 A, 60 Hz, secondary; bar or window type; with secondary shorting device; ratios as required; burden and accuracy class suitable for connected relays, meters, and instruments.
- B. Multifunction Digital-Metering Monitor (Power Monitor): UL-listed microprocessor-based unit suitable for three- or four-wire systems and with the following features:
1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
  2. Back-lighted LCD to display metered data with touch-screen selecting device. Display four values on one screen at same time.
  3. Switch-selectable digital display of the following parameters:
    - 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. Demand apparent power, three-phase total.
    - k. Accumulated energy (kWh and kVARh).
    - l. THD, current and voltage, per phase.
  4. 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 (kWh) and reactive energy (kVARh).
  5. Communications: Compatible with BAS or other associated network.
  6. Mounting: Display and control unit flush or semi-flush mounted in instrument compartment door.
- C. Relays: Comply with IEEE C37.90, types and settings as required; with test blocks and plugs.
- D. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.

- E. Control Power Supply: Control power transformer supplying 120-V control circuits through secondary disconnect devices. Include the following features:
  - 1. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
  - 2. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.
  - 3. Control power supply sources connected through a relay or relays to control bus to effect an automatic transfer scheme.
  - 4. Control Power Fuses: Primary and secondary fuses with current-limiting and overload protection.
  - 5. Fuses are specified in Division 26 Section "Fuses."
  
- F. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
  - 1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
  - 2. Conductors sized according to NFPA 70 for duty required.

## **2.5 CIRCUIT BREAKERS**

- A. Description: Draw-out type, unfused, power-operated, with electronic trip devices. Comply with IEEE C37.13, IEEE C37.13a, and UL 1066.
  
- B. Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.
  - 1. Circuit breakers shall have 30-cycle short-time withstand ratings equal to their symmetrical interrupting ratings through 42,000 A, whether or not equipped with instantaneous trip protection.
  
- C. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
  - 1. Normal Closing Speed: Independent of both control and operator.
  - 2. Slow Closing Speed: Optional with operator for inspection and adjustment.
  - 3. Stored-Energy Mechanism: Electrically charged, with optional manual charging.
    - a. Operating Handle: One for each circuit breaker capable of manual operation.
    - b. Electric Close Button: One for each electrically operated circuit breaker.
  - 4. Provide an interlock to discharge the stored energy mechanism before the circuit breaker can be withdrawn from its compartment.
  - 5. Operation counter.
  
- D. Operator Display: Located on the face of circuit breaker.
  - 1. Electrical operation buttons to open and close the circuit breaker. Provide a clear lockable cover over the buttons.
  - 2. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.
  - 3. Indicator to show the position of the circuit-breaker contacts, status of the closing springs, and circuit-breaker position in its compartment.
  - 4. Provide a "charged-not OK to close" indicator when closing springs are charged but circuit breaker is not ready to close.

- E. Overcurrent Trip Devices: Microprocessor-based, programmable, time-current shaping adjustments; complete with current transformers and sensors and the following features:
1. Programmable functions independent of each other in both action and adjustment.
    - a. Long-time setting.
    - b. Long-time-delay with selectable I<sup>2</sup>T or I<sup>4</sup>T curve shaping.
    - c. Short-time setting.
    - d. Short-time-delay with flat or selectable I<sup>2</sup>T curve shaping.
    - e. Instantaneous trip.
  2. Field-adjustable, time-current characteristics.
  3. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.
  4. Fully-programmable time-current characteristics. Programming may be done via a keypad at the faceplate of the unit or via the communication network
  5. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
  6. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I<sup>2</sup>t operation.
  7. Pickup Points: Five minimum, for instantaneous-trip functions.
  8. Ground-fault protection with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection appropriate for associated switchgear, source, and circuit configuration.
  9. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault.
  10. Local Display: 24-character LED digital display.
  11. Metering and Monitoring:
    - a. Circuit breaker status (open, closed, tripped.)
    - b. Protection settings.
    - c. History logs, including cause-of-trip.
    - d. Voltage, current, power, power factor, energy, frequency.
    - e. Adjustable high-load alarm.
    - f. Maintenance data.
    - g. Load-shedding settings and activation.
    - h. Power quality (harmonic content and THD.)
  12. Communications: Compatible with BAS or other associated network.
- F. Circuit Breakers 1200-A Frame Size and Greater: Equip circuit breakers with "Arc-Flash Reduction Maintenance System" settings and switch for use as a temporary arc-flash incident energy-reduction device during maintenance activities.
1. Provide a manual switch on the compartment door to switch the circuit-breaker short-time tripping characteristics to instantaneous with minimum pickup setting, to reduce the danger from potential arc-flash at downstream equipment.
  2. Provide a lock feature for the switch so that it may be locked in either the off or on maintenance-mode position.
  3. Provide a blue LED indicating light to indicate that the switch is in maintenance mode.
  4. Provide dry relay contacts on each switch for annunciation of the switch position.
- G. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.
- H. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.

- I. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of draw-out mechanism.
- J. Operating Handle: One for each circuit breaker capable of manual operation.
- K. Electric Close Button: One for each electrically-operated circuit breaker.
- L. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key-interlock devices is indicated.
- M. High Current Alarm: Adjustable time-delay and set-point.
- N. Under-voltage Trip Devices: Adjustable time-delay and pickup voltage.
- O. Shunt-Trip Devices: For each circuit breaker.

## **2.6 SURGE SUPPRESSION**

- A. Surge-Protective Devices (SPDs): Factory installed as an integral part of low-voltage switchgear, complying with UL 1449 SPD, Type 1, integrally-mounted in segregated compartment(s) within switchgear unit. Provide the following features and accessories:
  - 1. Integral disconnecting means.
  - 2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
  - 3. Fabrication using bolted compression lugs for internal wiring.
  - 4. Redundant suppression circuits.
  - 5. Redundant replaceable modules.
  - 6. LED indicator lights for power and protection status.
  - 7. Audible alarm, with silencing switch, to indicate when protection has failed.
  - 8. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device.
  - 9. Six-digit, transient-event counter set to totalize transient surges.
- B. Comply with UL 1283; EMI/RFI filtering with minimum attenuation of -50dB at 100kHz.
- C. MCOV of the SPD shall be at least 125 percent of the nominal associated system voltage.
- D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per mode shall not be less than 240 kA. The peak surge current rating shall be the arithmetic sum of the ratings of the individual MOVs in a given mode.
- E. SCCR: Equal or exceed 200 kA without fuses.
- F. Inominal Rating: 20 kA.

## **2.7 BAS INTERFACE**

- A. Interconnection to Building Automation System: Each low-voltage switchgear power monitor shall be fully-integrated with the building automation system (BAS) via a communications network connection. Coordinate required interface protocol with BAS supplier and provide BAS supplier with a comprehensive points list to facilitate system programming. Refer to HVAC controls diagrams and sequences for additional information. In addition to required low-voltage switchgear monitoring points indicated on HVAC controls diagrams and sequence, BAS shall monitor the following:

1. Total switchgear kW.
2. SPD operation and condition.
3. Alarm conditions.

## **2.8 ACCESSORIES**

- A. Accessory Set: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.
1. Racking handle to manually move circuit breaker between connected and disconnected positions.
  2. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
  3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
- B. Circuit-Breaker Removal Apparatus: Portable, floor-supported, roller-base, elevating carriage arranged for moving circuit breakers in and out of compartments.
- C. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.
- D. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

## **2.9 DIFFERENTIAL GROUND-FAULT PROTECTION**

- A. Description: Ground-fault protection system for three-phase, four-wire switchgear having multiple sources shall be devised by manufacturer to ensure that the proper main or tie breaker(s) operate properly in normal and emergency conditions. Switchgear shall include additional current transformers, ground-fault relays, interlocks, wiring, and accessories to avoid nuisance tripping of circuit breakers connected to the main bus of the switchgear. Ensure that the following occurs on the main bus:
1. A ground fault at any location in the switchgear shall trip the system.
  2. Combination of normal current flow and ground-fault current flow shall trip the system.
  3. Circulating currents through the neutral due to multiple grounds and sources external to the immediate low-voltage power sources shall not trip the system.
  4. System shall not trip if there is no ground fault, during normal current flow.
  5. System shall not trip due to large single-phase currents.
- B. Relays: Comply with IEEE C37.90, with test blocks and plugs.
- C. Control Wiring:
1. Factory installed, complete with bundling, lacing, and protection.
  2. Provide flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
  3. Install plugs in control wiring at shipping splits.

## **2.10 IDENTIFICATION**

- A. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.

2. Medium: Painted graphics, as selected by Architect.
  3. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.
- B. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:
1. Frame size of each circuit breaker.
  2. Trip rating for each circuit breaker.
  3. Conduit and wire size for each feeder.

## **2.11 SOURCE QUALITY CONTROL**

- A. Testing: Test and inspect low-voltage switchgear according to IEEE C37.20.1. Draw-out circuit breakers need not be tested in the assembly if they are tested separately.
1. Dielectric Tests: Perform power-frequency withstand tests to demonstrate the ability of the insulation system to withstand the voltages listed in IEEE C37.20.1. The voltage is to be increased gradually from zero to the required test value within 5 to 10 seconds and shall be held at that value for one minute.
  2. Perform mechanical operation tests to ensure proper functioning of operating mechanism, mechanical interlocks, and interchangeability of removable elements that are designed to be interchangeable.
  3. Test the effectiveness of grounding of each metal-case instrument transformer frame or case.
  4. Verify that control wiring is correct by verifying continuity. Perform electrical operation of component devices to ensure that they function properly and in the intended sequence.
  5. Perform the control wiring insulation tests.
  6. Verify correct polarity of the connections between instrument transformers and meters and relays.
- B. Low-voltage switchgear assembly will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. Owner may elect to witness 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 elements and surfaces where switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance.
- 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 the section barriers to reach load or line lugs.
- C. Examine walls, floors, roofs, and concrete bases for suitable conditions where switchgear will be installed.

- D. Verify that ground connections are in place and that requirements in Division 26 "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be five ohms at the switchgear location.
- E. On delivery of switchgear and prior to unloading, inspect equipment for damage.
  - 1. Verify that tie rods and chains are undamaged and tight, and that blocking and bracing are tight.
  - 2. Verify that there is no evidence of load shifting in transit, and that readings from transportation shock recorders, if equipped, are within manufacturer's written instructions.
  - 3. Examine switchgear for external damage, including dents or scratches in doors and sill, and termination provisions.
  - 4. Compare switchgear and accessories received with the bill of materials to verify that the shipment is complete. Verify that switchgear and accessories comply with manufacturer's written instructions and Shop Drawings. If the shipment is incomplete or does not comply with Project requirements, notify manufacturer in writing immediately.
  - 5. Unload switchgear, observing packing label warnings and handling instructions.
  - 6. Open compartment doors and inspect components for damage or displaced parts, loose or broken connections, cracked or chipped insulators, bent mounting flanges, dirt or foreign material, and water or moisture.
- F. Handling:
  - 1. Handle switchgear, according to manufacturer's written instructions; avoid damage to the enclosure, termination compartments, base, frame, tank, and internal components. Do not subject switchgear to impact, jolting, jarring, or rough handling.
  - 2. Protect switchgear compartments against the entrance of dust, rain, and snow.
  - 3. Transport switchgear upright, to avoid internal stresses on equipment mounting assemblies. Do not tilt or tip switchgear.
  - 4. Use spreaders or a lifting beam to obtain a vertical lift and to protect switchgear from straps bearing against the enclosure. Lifting cable pull angles may not be greater than 15 degrees from vertical.
  - 5. Do not damage structure when handling switchgear.
- G. Proceed with installation only after examinations are complete and unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Comply with applicable portions of NECA 400.
- B. Anchor switchgear assembly to 4-inch, channel-iron floor sill embedded in concrete base and attach by bolting.
  - 1. Sills: Select to suit switchgear; level and grout flush into concrete base.
  - 2. Concrete Bases: 4 inches high, reinforced, with chamfered edges. Extend base no more than 3 inches in all directions beyond the maximum dimensions of switchgear unless otherwise indicated or unless required for seismic anchor support.
- C. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

### **3.3 IDENTIFICATION**

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Electrical Identification."
- B. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a nameplate complying with requirements for identification specified in Division 26 Section "Electrical Identification."
- C. Diagram and Instructions:
  - 1. Frame and mount under clear acrylic plastic on the front of switchgear.
    - a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
    - b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.
  - 2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

### **3.4 CONNECTIONS**

- A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- B. Connect wiring according to Division 26 Section "Low-Voltage Conductors and Cables."

### **3.5 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
  - 1. Comply with provisions of NFPA 70B, "Testing and Test Methods" Chapter and of NETA ATS.
  - 2. After installing switchgear 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 ATS. Certify compliance with test parameters.
  - 4. Visual and Mechanical Inspection:
    - a. Verify that fuse and circuit-breaker sizes and types correspond to Drawings and coordination study.
    - b. Verify that current and voltage transformer ratios correspond to Drawings.
    - c. Inspect bolted electrical connections for high resistance using one of the following two methods:
      - 1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.



- d. Confirm correct operation and sequencing of electrical and mechanical interlock systems.
    - 1) Attempt closure on locked-open devices. Attempt to open locked-closed devices.
    - 2) Make key exchange with devices operated in off-normal positions.
  - e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
  - f. Inspect insulators for evidence of physical damage or contaminated surfaces.
  - g. Verify correct barrier and shutter installation and operation.
  - h. Exercise active components.
  - i. Inspect mechanical indicating devices for correct operation.
  - j. Verify that filters are in place and that vents are clear.
  - k. Perform visual and mechanical inspection of instrument transformers according to "Instrument Transformer Field Tests" Paragraph.
  - l. Inspect control power transformers.
    - 1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
    - 2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
    - 3) Verify correct functioning of draw-out disconnecting and grounding contacts and interlocks.
5. Electrical Tests:
- a. Perform dc voltage insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground, for one minute. If the bus temperature is other than plus or minus 20 deg C, adjust the resulting resistance as provided in NETA ATS, Table 100.11.
    - 1) Insulation-resistance values of bus insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.1.
    - 2) Do not proceed to the dielectric withstand voltage tests until insulation-resistance levels are raised above minimum values.
  - b. Perform a dielectric withstand voltage test on each bus section, phase-to-ground with phases not under test grounded, according to manufacturer's published data. If manufacturer has no recommendation for this test, it shall be conducted according to NETA ATS, Table 100.2. Apply the test voltage for one minute.
    - 1) If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the test specimen is considered to have passed the test.
  - c. Perform insulation-resistance tests on control wiring for ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid-state components or control devices that cannot tolerate the applied voltage, follow the manufacturer's written instruction.
    - 1) Minimum insulation-resistance values of control wiring shall not be less than 2 megohms.
  - d. Control Power Transformers:
    - 1) Perform insulation-resistance tests. Perform measurements from winding-to-winding and each winding-to-ground. Insulation-resistance values of winding

insulation shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.1.

- 2) Perform secondary wiring integrity test. Disconnect transformer at secondary terminals and connect secondary wiring to a rated secondary voltage source. Verify correct potential at all devices.
- 3) Verify correct secondary voltage by energizing the primary winding with system voltage. Measure secondary voltage with the secondary wiring disconnected.
- 4) Verify correct function of control transfer relays located in the switchgear with multiple control power sources.

e. Voltage Transformers:

- 1) Perform secondary wiring integrity test. Verify correct potential at all devices.
- 2) Verify secondary voltages by energizing the primary winding with system voltage.

f. Perform current-injection tests on the entire current circuit in each section of switchgear.

- 1) Perform current tests by secondary injection with magnitudes such that a minimum 1.0-A current flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.
- 2) Perform current tests by primary injection with magnitudes such that a minimum 1.0-A current flows in the secondary circuit. Verify correct magnitude of current at each device in the circuit.

g. Perform system function tests according to "System Function Tests" Article.

h. Verify operation of space heaters.

i. Perform phasing checks on double-ended or dual-source switchgear to ensure correct bus phasing from each source.

D. Circuit-Breaker Field Tests:

1. Visual and Mechanical Inspection:

- a. Inspect physical and mechanical condition.
- b. Inspect anchorage, alignment, and grounding.
- c. Verify that all maintenance devices are available for servicing and operating the breaker.
- d. Verify the unit is clean.
- e. Verify that the arc chutes are intact.
- f. Inspect moving and stationary contacts for condition and alignment.
- g. Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.
- h. Perform mechanical operator and contact alignment tests on both the breaker and its operating mechanism according to manufacturer's published data.
- i. Verify cell fit and element alignment.
- j. Verify racking mechanism operation.
- k. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
- l. Perform adjustments for final protective-device settings according to coordination study provided by Owner.
- m. Record as-found and as-left operation counter readings.

2. Electrical Tests:

- a. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to ground with switch closed, and across each open pole. Apply voltage

according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.1. Insulation-resistance values shall be according to manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.1. Values of insulation resistance less than Table 100.1 or manufacturer's written instructions shall be investigated.

- b. Measure contact resistance across each power contact of the circuit breaker. Microhm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in manufacturer's published data. In the absence of manufacturer's published data, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
- c. Determine long-time pickup and delay by primary current injection. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are unavailable, trip times shall not exceed the value shown in NETA ATS, Table 100.7.
- d. Determine short-time pickup and delay by primary current injection. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
- e. Determine ground-fault pickup and delay by primary current injection. Ground-fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
- f. Determine instantaneous pickup value by primary current injection. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.8.
- g. Test functions of the trip unit by means of secondary injection. Pickup values and trip characteristic shall be as specified and within manufacturer's published tolerances.
- h. Perform minimum pickup voltage tests on shunt trip and close coils according to manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall comply with manufacturer's published data. In the absence of manufacturer's published data, comply with NETA ATS, Table 100.20.
- i. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- j. Verify correct operation of any auxiliary features, such as trip and pickup indicators, zone interlocking, electrical close and trip operation, trip-free operation, antipump function, and trip-unit battery condition. Reset trip logs and indicators. Auxiliary features shall operate according to manufacturer's published data.
- k. Verify operation of charging mechanism. Charging mechanism shall operate according to manufacturer's published data.

E. Instrument Transformer Field Tests:

1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data complies with the Contract Documents.
- b. Inspect physical and mechanical condition.
- c. Verify correct connection of transformers with system requirements.
- d. Verify that adequate clearances exist between primary and secondary circuit wiring.
- e. Verify that the unit is clean.
- f. Inspect bolted electrical connections for high resistance using one of the following two methods:
  - 1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published

data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

- g. Verify that required grounding and shorting connections provide contact.
- h. Verify correct operation of transformer withdrawal mechanism and grounding operation.
- i. Verify correct primary and secondary fuse sizes for voltage transformers.
- j. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.

2. Electrical Tests of Current Transformers:

- a. Perform insulation-resistance test of each current transformer and its secondary wiring for ground at 1000-V dc for one minute. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's written instructions. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.5.
- b. Perform a polarity test of each current transformer according to IEEE C57.13.1. Polarity results shall agree with transformer markings.
- c. Perform a ratio-verification test using the voltage or current method according to IEEE C57.13.1. Ratio errors shall be according to IEEE C57.13.
- d. Perform an excitation test on transformers used for relaying applications according to IEEE C57.13.1. Excitation results shall match the curve supplied by manufacturer or be according to IEEE C57.13.1.
- e. Measure current circuit burdens at transformer terminals according to IEEE C57.13.1. Measured burdens shall be compared to, and shall match, instrument transformer ratings.
- f. Perform insulation-resistance tests on the primary winding with the secondary grounded. Test voltages shall be according to NETA ATS, Table 100.5.
- g. Perform dielectric withstand tests on the primary winding with the secondary grounded. Test voltages shall be according to NETA ATS, Table 100.9.
- h. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data.
- i. Verify that current transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3. That grounding point should be located as specified by Engineer in Project Drawings.

3. Electrical Tests of Voltage Transformers:

- a. Perform insulation-resistance tests, winding-to-winding and winding-to-ground. Test voltages shall be applied for one minute according to NETA ATS Table 100.5. For units with solid-state components that cannot tolerate the applied voltage, follow manufacturer's written instructions. Investigate and correct values of insulation resistance less than manufacturer's written instructions or NETA ATS, Table 100.5.
- b. Perform a polarity test on each transformer to verify the polarity marks or H1-X1 relationship as applicable. Polarity results shall agree with transformer markings.
- c. Perform a turns-ratio test on all tap positions. Ratio errors shall be according to IEEE C57.13.
- d. Measure voltage circuit burdens at transformer terminals. Measured burdens shall be compared to, and shall match, instrument transformer ratings.
- e. Perform a dielectric withstand test on the primary windings with the secondary windings connected to ground. Dielectric voltage shall be according to NETA ATS, Table 100.9. Test voltage shall be applied for one minute. If no evidence of distress or insulation failure is observed by the end of the total time of voltage application during the dielectric withstand test, the primary windings are considered to have passed the test.
- f. Perform power-factor or dissipation-factor tests according to test equipment manufacturer's published data. Power-factor or dissipation-factor values shall be according to manufacturer's published data. In the absence of manufacturer's published data, use test equipment manufacturer's published data.

- g. Verify that voltage transformer secondary circuits are grounded and have only one grounding point according to IEEE C57.13.3. Test results shall indicate that the circuits are grounded at only one point.

F. Ground-Resistance Test:

1. Visual and Mechanical Inspection:

- a. Verify that ground system complies with the Contract Documents and with NFPA 70, Article 250, "Grounding and Bonding."
- b. Inspect physical and mechanical condition. Grounding system electrical and mechanical connections shall be free of corrosion.
- c. Inspect bolted electrical connections for high resistance using one of the following two methods:
  - 1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
- d. Inspect anchorage.

2. Electrical Tests:

- a. Perform fall-of-potential or alternative test according to IEEE 81 on the main grounding electrode or system. Resistance between the main grounding electrode and ground shall be no more than five ohms.
- b. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and derived neutral points. Investigate point-to-point resistance values that exceed 0.5 ohms. Compare equipment nameplate data with the Contract Documents.
- c. Inspect physical and mechanical condition.
- d. Inspect bolted electrical connections for high resistance using one of the following two methods:
  - 1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.

G. Metering Devices Field Tests:

1. Visual and Mechanical Inspection:

- a. Inspect physical and mechanical condition.
- b. Inspect bolted electrical connections for high resistance using one of the following two methods:

- 1) Use a low-resistance ohmmeter to compare bolted-connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data or NETA ATS, Table 100.12. Bolt-torque levels shall be according to manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS, Table 100.12.
- c. Inspect cover gasket, cover glass, condition of spiral spring, disk clearance, contacts, and case shorting contacts, as applicable.
  - d. Verify that the unit is clean.
  - e. Verify freedom of movement, end play, and alignment of rotating disk(s).
2. Electrical Tests:
    - a. Verify accuracy of meters at all cardinal points. Meter accuracy shall be according to manufacturer's published data.
    - b. Calibrate meters according to manufacturer's published data. Calibration results shall be within manufacturer's published tolerances.
    - c. Verify all instrument multipliers. Instrument multipliers shall be according to system design specifications.
    - d. Verify that current transformer and voltage transformer secondary circuits are intact. Test results shall confirm the integrity of the secondary circuits of current and voltage transformers.
- H. Microprocessor-Based Protective Relay Field Tests:
1. Visual and Mechanical Inspection:
    - a. Record model number, style number, serial number, firmware revision, software revision, and rated control voltage.
    - b. Verify operation of LEDs, display, and targets.
    - c. Record passwords for each access level.
    - d. Clean the front panel and remove foreign material from the case.
    - e. Check tightness of connections.
    - f. Verify that the frame is grounded according to manufacturer's written instructions.
    - g. Set the relay according to results in Division 26 "Electrical Studies and Settings."
    - h. Download settings from the relay. Print a copy of the settings for the report and compare the settings to those specified in the coordination study.
  2. Electrical Tests:
    - a. Perform insulation-resistance tests from each circuit to the grounded frame according to manufacturer's published data.
    - b. Apply voltage or current to analog inputs, and verify correct registration of the relay meter functions.
    - c. Check functional operation of each element used in the protection scheme.
    - d. Control Verification:
      - 1) Functional Tests:
        - a) Check operation of all active digital inputs.
        - b) Check output contacts or SCRs, preferably by operating the controlled device, such as circuit breaker, auxiliary relay, or alarm.
        - c) Check internal logic functions used in protection scheme.

- d) On completion of testing, reset minimum/maximum recorders, communications statistics, fault counters, sequence-of-events recorder, and event records.
  - 2) In-Service Monitoring: After the equipment is initially energized, measure magnitude and phase angle of inputs and verify expected values.
- I. Ground-Fault Protection Field Tests: Evaluate the interconnected system according to switchgear manufacturer's written instructions.
  - 1. Determine the proper location of the sensors around the bus of the circuit to be protected. This determination may be done visually, with knowledge of which bus is involved.
  - 2. Verify the grounding points of the system to determine that ground paths do not exist that would bypass the sensors. Use high-voltage testers and resistance bridges.
  - 3. Test the installed system for correct response by application of full-scale current into the equipment to duplicate a ground-fault condition, or by equivalent means such as by simulated fault current generated by the following:
    - a. A coil around the sensors.
    - b. A separate test winding in the sensors.
  - 4. Record the test results on the test form provided with the instructions provided by manufacturer.
- J. Switchgear components will be considered defective if they do not pass tests and inspections.
- K. Remove and replace defective units and retest.
- L. Prepare test and inspection reports. Record as-left set points of adjustable devices.

### **3.6 SYSTEM FUNCTION TESTS**

- A. System function tests shall prove the correct interaction of sensing, processing, and action devices. Perform system function tests after field quality-control tests have been completed and all components have passed specified tests.
  - 1. Develop test parameters and perform tests for the purpose of evaluating performance of integral components and their functioning as a complete unit within design requirements and manufacturer's published data.
  - 2. Verify the correct operation of interlock safety devices for fail-safe functions in addition to design function.
  - 3. Verify the correct operation of sensing devices, alarms, and indicating devices.
- B. Switchgear will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### **3.7 FOLLOW-UP SERVICE**

- A. Voltage Monitoring and Adjusting: After Substantial Completion, but not more than six months after Final Acceptance, and if requested by Owner, perform the following voltage monitoring:
  - 1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each piece of switchgear. Use voltmeters with calibration traceable to NIST standards and with a chart speed of not less than 1 inch per hour. Voltage unbalance greater than 1 percent between phases, or deviation of phase voltage

from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.

2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

- a. Adjust switchgear taps.
- b. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action has been performed, until specified results are obtained.

4. Report:

- a. Prepare a written report covering monitoring performed and corrective action taken.

- B. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 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 switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### **3.8 ADJUSTING**

- A. Set field-adjustable, protective-relay trip characteristics according to results in Division 26 Section "Electrical Studies and Settings."

### **3.9 CLEANING**

- A. On completion of installation, inspect interior and exterior of switchgear. 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.

### **3.10 PROTECTION**

- A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

### **3.11 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear. Refer to Division 01 Section "Demonstration and Training."
- B. Demonstrate that equipment under this Section is properly monitored at the front-end of the building automation system.

END OF SECTION 26 23 00





## **SECTION 26 24 16 - PANELBOARDS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Distribution panelboards.
  - 2. Branch circuit panelboards.

#### **1.3 DEFINITIONS**

- A. Inominal: Nominal discharge current.
- B. MCOV: Maximum continuous operating voltage.
- C. OCPD: Overcurrent protective device.
- D. SCCR: Short-circuit current rating.
- E. SPD: Surge-protective device.
- F. VPR: Voltage protection rating.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, surge-protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on materials, features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details.
  - 2. Show tabulations of installed devices, equipment features, and ratings.
  - 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
  - 4. Detail bus configuration, phasing, current, and voltage ratings.
  - 5. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 7. Include wiring diagrams for power, signal, and control wiring.
  - 8. SPD: Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories. Provide a copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection. Include evidence of NRTL listing for SPD as installed in panelboard.
- C. Comprehensive Product Data and Shop Drawing Submittal Package: Submit product data and shop drawing information for all items specified under this Section in a single comprehensive Product Data and Shop Drawing Submittal Package. This Submittal Package shall contain only items specified under, or directly related to, this Section. Submittals that do not include each specified unit or contain incomplete submittal information will be rejected.
- D. Qualification Data: For testing agency.
- E. Field Quality-Control Reports:

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. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- G. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

## **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 NETA.
1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- C. Manufacturer Qualifications: ISO 9001 or 9002 certified.
- 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. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- F. Comply with NEMA PB 1.
- G. Comply with NFPA 70.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. Handle and prepare panelboards for installation according to NEMA PB 1.

## **1.7 PROJECT CONDITIONS**

- A. Environmental Limitations: Do not deliver or install panelboards until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

## **1.8 COORDINATION**

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

## **1.9 WARRANTY**

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
  - 1. Panelboard Warranty Period: 18 months from date of Substantial Completion.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace surge-protective devices that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

## **1.10 EXTRA MATERIALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Keys: Two spares for each type of panelboard cabinet lock.
  - 2. Circuit Breakers Including AFCI, GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard equipped with AFCI, GFCI or GFEP.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL REQUIREMENTS FOR PANELBOARDS AND LOAD CENTERS**

- A. Manufacturers: Provide products by Square D; a brand of Schneider Electric. or approved equivalent.
- B. Enclosures: Flush- and surface-mounted cabinets.
  - 1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    - b. Outdoor Locations: NEMA 250, Type 4X, stainless steel.
    - c. Kitchens and Other Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
    - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4X, stainless steel.
    - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Non-corrosive Liquids: NEMA 250, Type 12.
  - 2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
  - 3. Finishes:
    - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pre-treating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    - b. Back Boxes: Galvanized steel.
  - 4. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- C. Circuit Breaker Arrangement: Single-pole circuit breakers shall be arranged as follows:
  - 1. Single-phase load centers: A-B top to bottom.
  - 2. Three-phase panels: A-B-C top to bottom.
- D. Incoming Mains Location: Top and bottom.
- E. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper of 98 percent conductivity
  2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
  3. Isolated Ground Bus: Where indicated, provide isolated ground bus adequate for branch-circuit isolated ground conductors; insulated from box.
  4. Extra-Capacity Neutral Bus: Where indicated, provide neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
- F. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper of 98 percent conductivity.
  2. Main and Neutral Lugs: Compression or mechanical type.
  3. Ground Lugs and Bus-Configured Terminators: Compression or mechanical type.
  4. Feed-Through Lugs: Compression or mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  5. Subfeed (Double) Lugs: Compression or mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
  6. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- G. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- H. Spare Devices: Each panelboard shall be equipped with a minimum of 20 percent spare devices for the connection of future circuits, unless a greater quantity of spare devices are indicated elsewhere.
1. Provide a minimum of one matching spare device for each size and type of device provided.
- I. Future Devices: Each panelboard shall be equipped with mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of the following quantity of devices, unless a greater quantity of future devices are indicated elsewhere:
1. Distribution Panelboards: Minimum 30 percent.
  2. Branch Circuit Panelboards: Minimum 20 percent.
  3. Load Centers: Minimum 20 percent.
  4. Include provisions for at least one matching future device for each size and type device provided.
- J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals; except series-rated equipment is acceptable for residential unit load centers.

## **2.2 PERFORMANCE REQUIREMENTS**

- A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

## **2.3 DISTRIBUTION PANELBOARDS**

- A. Panelboards: NEMA PB 1, distribution type.
- B. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
1. For doors more than 36 inches high, provide two latches, keyed alike.
- C. Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

1. Branch devices may utilize plug-in style circuit breakers where individual positive-locking device requires mechanical release for removal.
- D. SPD: Branch-mounted in each distribution panelboard.

1. Factory-installed, integral SPD; labeled by an NRTL for compliance with UL 67 after installing SPD. Minimum peak surge current rating: 200kA.

## **2.4 BRANCH CIRCUIT PANELBOARDS**

- A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- B. Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- C. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
- D. SPD: Branch-mounted in branch-circuit panelboards indicated.

1. Factory-installed, integral SPD; labeled by an NRTL for compliance with UL 67 after installing SPD. Minimum peak surge current rating: 100kA.

## **2.5 OVERCURRENT PROTECTIVE DEVICES**

- A. Molded-Case Circuit Breaker (MCCB): Comply with 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. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; 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. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
6. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
7. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
8. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
  - a. Standard frame sizes, trip ratings, and number of poles.
  - b. Lugs: Compression or mechanical style, suitable for number, size, trip ratings, and conductor materials.
  - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

- d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
- e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 55 percent of rated voltage.
- f. Under-voltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
- g. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
- h. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
- i. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- j. Multi-pole units enclosed in a single housing or factory assembled to operate as a single unit.
- k. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
- l. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

## **2.6 IDENTIFICATION**

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in metal frame with transparent protective cover.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.
- D. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

## **2.7 SURGE-PROTECTIVE DEVICES**

- A. SPDs: Listed and labeled by UL 1449 Fourth Edition as Type 1, intended for use without need for external or supplemental over-current controls. Every suppression component of every mode, including N-G, protected by internal over-current and thermal over-temperature controls. SPDs relying on external or supplementary installed safety disconnectors are not acceptable.
- B. Description: IEEE C62.41-compliant, integrally-mounted within panelboard compartment, plug-in, solid-state, parallel-connected, modular (with field-replaceable modules) type, with sine-wave tracking suppression and filtering modules, short-circuit current rating complying with UL 1449, fourth edition, and matching or exceeding the panelboard short-circuit rating, redundant suppression circuits with individually fused metal-oxide varistors, and with the following features and accessories:
  - 1. Fabrication using bolted compression lugs for internal wiring.
  - 2. Redundant suppression circuits.
  - 3. Redundant replaceable modules.

4. LED indicator lights for power and protection status.
  5. Audible alarm, with silencing switch, to indicate when protection has failed.
  6. Form-C contacts rated at 5 A and 250-V ac, one normally open and one normally closed, for remote monitoring of system operation. Contacts shall reverse position on failure of any surge diversion module or on opening of any current-limiting device. SPD operation and condition shall be monitored via the building automation system.
  7. Six-digit, transient-event counter set to totalize transient surges.
- C. Comply with UL 1283; EMI/RFI filtering with minimum attenuation of -50dB at 100kHz.
- D. MCOV of the SPD shall be at least 125 percent of the nominal associated system voltage.
- E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:
1. Line to Neutral: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.
  2. Line to Ground: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.
  3. Neutral to Ground: 1200 V for 480Y/277 V; 700 V for 208Y/120 V.
  4. Line to Line: 2000 V for 480Y/277 V; 1200 V for 208Y/120 V
- F. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:
1. Line to Neutral: 700 V.
  2. Line to Ground: 700 V.
  3. Neutral to Ground: 700 V.
  4. Line to Line: 1200 V.
- G. SCCR: Equal or exceed 200 kA without fuses.
- H. Inominal Rating: 20 kA.
- I. Concealment: For panelboards not located in electrical, mechanical or telecommunications rooms, mount SPD so it is concealed behind panelboard cover when door is closed.

## **2.8 ACCESSORY COMPONENTS AND FEATURES**

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.



### **3.2 INSTALLATION**

- A. Comply with NECA 1.
- B. Install panelboards and accessories according to NEMA PB 1.1.
- C. Equipment Mounting: Install floor-mounted panelboards on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
  - 2. For panelboards, 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 panelboards.
  - 5. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- E. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- F. Mount top of trim 90 inches above finished floor unless otherwise indicated. Ensure that operating handle of top-most switch or circuit breaker, in on position, is not higher than 79 inches above finished floor or grade. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- H. Mount surface-mounted panelboards to steel slotted supports. Orient steel slotted supports vertically.
- I. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
  - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- J. Install filler plates in unused spaces.
- K. Stub four 1-1/2-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-1/2-inch empty conduits into raised floor space or below slab not on grade.
- L. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- M. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length.

### **3.3 IDENTIFICATION**

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Electrical Identification."

### **3.4 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 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.
  - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 4. 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 panelboard. 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 panelboard 11 months after date of Substantial Completion.
    - c. Instruments and Equipment:
      - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### **3.5 ADJUSTING**

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Electrical Studies and Settings."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
  - 1. Measure as directed during period of normal system loading.
  - 2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 10 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.
5. Revise color-coding of conductors to reflect phase alterations.

### **3.6 PROTECTION**

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

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## **SECTION 26 27 26 - WIRING DEVICES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Straight-blade receptacles.
  - 2. GFCI receptacles.
  - 3. Twist-locking receptacles.
  - 4. Snap switches.
  - 5. Digital timer switches.
  - 6. Wall-box dimmers.
  - 7. Solid-state fan speed controls.
  - 8. Wall plates.
  - 9. Multi-outlet assemblies.
  - 10. Floor outlets.
  - 11. Floor boxes
  - 12. Poke-through assemblies.

#### **1.3 DEFINITIONS**

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: List of legends and description of materials and process used for pre-marking wall plates.
- C. Comprehensive Product Data and Shop Drawing Submittal Package: Submit product data and shop drawing information for all items specified under this Section in a single comprehensive Product Data and Shop Drawing Submittal Package. This Submittal Package shall contain only items specified under, or directly related to, this Section. Submittals that do not include each specified unit or contains incomplete submittal information will be rejected.
- D. Field quality-control test reports.
- E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

#### **1.5 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. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.
- C. Comply with NFPA 70.
- D. Comply with NEMA WD 1.
- E. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
  - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
  - 2. Devices shall comply with requirements in this Section.

## **1.6 COORDINATION**

- A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

## **1.7 EXTRA MATERIALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. GFCI Receptacles: One for every 10 of each type installed, but no fewer than two of each type.
  - 2. SPD Receptacles: One for every 10 of each type installed, but no fewer than two of each type.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
  - 1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).
  - 2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
  - 3. Leviton Mfg. Company Inc. (Leviton).
  - 4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

### **2.2 STRAIGHT BLADE RECEPTACLES**

- A. Construction Specification Grade, Duplex Convenience Receptacles, 125 V, 20 A, Back and Side Wired: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Pass & Seymour, CRB5362 Series or comparable product by Cooper, Hubbell or Leviton.
- B. Specification Grade Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Pass & Seymour, TR63 Series or comparable product by Cooper, Hubbell or Leviton.

### **2.3 GFCI RECEPTACLES**

- A. General Description: Specification Grade Straight blade, feed-through or non-feed-through type, depending on application. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.
- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Pass & Seymour, 2097 Series or comparable product by Cooper, Hubbell or Leviton.
- C. Tamper Resistant duplex GFCI Convenience Receptacles, 125 V, 20 A:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Pass & Seymour, 2097TR Series or comparable product by Cooper, Hubbell or Leviton.

## **2.4 TWIST-LOCKING RECEPTACLES**

- A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration L5-20R, and UL 498.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Pass & Seymour, L5-20R Series or comparable product by Cooper, Hubbell or Leviton.

## **2.5 SNAP SWITCHES**

- A. Comply with NEMA WD 1 and UL 20.

- B. Hard Use Commercial Specification Grade Switches, 120/277 V, 20 A:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Pass & Seymour, CSB20AC1 Series or comparable product by Cooper, Hubbell or Leviton.

## **2.6 DIGITAL TIMER LIGHT SWITCH**

- A. Description: Switchbox-mounted, combination digital timer and conventional switch lighting-control unit, with backlit digital display, with adjustable time-out interval from 5 minutes to 12 hours. Refer to Drawings for additional requirements.

## **2.7 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 toggle switch; 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.

1. 2000 W; dimmers shall require no derating when ganged with other devices. Illuminated when "OFF."

- 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.

## **2.8 FAN SPEED CONTROLS**

- A. Modular, 120-V, full-wave, solid-state units with integral, quiet on-off switches and audible frequency and EMI/RFI filters. Comply with UL 1917.

1. Continuously adjustable rotary knob, 5 A.
2. Three-speed adjustable rotary knob, 1.5 A.

## **2.9 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: 0.035-inch-thick, satin-finished stainless steel.
3. Material for Unfinished Spaces: Galvanized steel.

4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."
  5. Color and Finish: As selected by Architect from manufacturer's full range.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant, die-cast aluminum with lockable cover.

## **2.10 MULTI-OUTLET ASSEMBLIES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Hubbell Incorporated; Wiring Device-Kellems.
  2. Wiremold Company (The).
- B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: Metal, with manufacturer's standard finish.
- D. Wire: No. 12 AWG minimum.

## **2.11 FLOOR OUTLETS**

- A. Description: Refer to Drawings for requirements.

## **2.12 FLOOR BOXES**

- A. Description: Refer to Drawings for requirements.

## **2.13 POKE-THROUGH ASSEMBLIES**

- A. Description: Factory-fabricated and -wired assembly of below-floor junction box with multi-channeled, through-floor raceway/firestop unit and detachable matching floor service-outlet assembly. Refer to Drawings for additional requirements.
- B. Comply with UL 514 scrub water exclusion requirements.

## **2.14 FINISHES**

- A. Color: Wiring device catalog numbers in Section Text do not designate device color.
1. Wiring Devices Connected to Normal Power System: White or as selected by Architect, unless otherwise indicated or required by NFPA 70 or device listing.
  2. Wiring Devices Connected to Emergency Power System: Red.

## **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 ensure 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. Pigtailling 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 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, and on horizontally mounted receptacles to the left. Confirm receptacle orientation with Owner prior to installation.

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. Group adjacent switches under single, multi-gang wall plates.

### 3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Identification for Electrical Systems."



- B. Identify each receptacle with panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-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 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. 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 ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION

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## **SECTION 26 28 13 - FUSES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Cartridge fuses rated 600 V and less.
  - 2. Spare-fuse cabinets.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
  - 1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
  - 2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
  - 3. Current-limitation curves for fuses with current-limiting characteristics.
  - 4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse. Submit in electronic format suitable for use in coordination software and in PDF format.
  - 5. Coordination charts and tables and related data.
  - 6. Fuse sizes for elevator feeders and elevator disconnect switches.
- B. Comprehensive Product Data Submittal Package: Submit product data information for all items specified under this Section in a single comprehensive Product Data Submittal Package. This Submittal Package shall contain only items specified under, or directly related to, this Section. Submittals that do not include each specified unit or contains incomplete submittal information will be rejected.
- C. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 "Operation and Maintenance Data," include the following:
  - 1. Ambient temperature adjustment information.
  - 2. Current-limitation curves for fuses with current-limiting characteristics.
  - 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in electronic format suitable for use in coordination software and in PDF format.
  - 4. Coordination charts and tables and related data.

#### **1.4 QUALITY ASSURANCE**

- A. Source Limitations: Obtain fuses 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 NEMA FU 1.
- D. Comply with NFPA 70.

#### **1.5 PROJECT CONDITIONS**

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

#### **1.6 COORDINATION**

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

#### **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. Fuses: Quantity equal to 10 percent of each fuse type and size, but no fewer than 3 of each type and size.

### **PART 2 - PRODUCTS**

#### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Cooper Bussman, Inc.
  - 2. Eagle Electric Mfg. Co., Inc.; Cooper Industries, Inc.
  - 3. Ferraz Shawmut, Inc.
  - 4. Tracor, Inc.; Littelfuse, Inc. Subsidiary.

#### **2.2 CARTRIDGE FUSES**

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuse; class and current rating indicated; voltage rating consistent with circuit voltage.

#### **2.3 SPARE-FUSE CABINET**

- A. Cabinet: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
  - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
  - 2. Finish: Gray, baked enamel.
  - 3. Identification: "SPARE FUSES" in 1-1/2-inch-high letters on exterior of door.
  - 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 FUSE APPLICATIONS**

- A. Cartridge Fuses: Unless otherwise indicated, provide the following fuse type for application:
  - 1. Service Entrance: Class L, time delay.
  - 2. Feeders (Greater than 600A): Class L, time delay.
  - 3. Large Motor Branch Circuits (Greater than 600A): Class L, time delay.
  - 4. Feeders (600A or Less): Class RK1, time delay.
  - 5. Small Motor Branch Circuits (600A or Less): Class RK1, time delay.
  - 6. Other Branch Circuits: Class J, time delay.
  - 7. Power Electronics Circuits: Class J or T, high speed
  - 8. Control Transformer Circuits: Class CC, time delay, control transformer duty.

### **3.3 INSTALLATION**

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinets in each main electrical room and in other locations as indicated.

### **3.4 IDENTIFICATION**

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 26 28 13

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## **SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Fusible and non-fusible switches.
  - 2. Molded-case circuit breakers.
  - 3. Molded-case switches.
  - 4. Enclosures.

#### **1.3 DEFINITIONS**

- A. HD: Heavy duty.
- B. NC: Normally closed.
- C. NO: Normally open.
- D. SPDT: Single pole, double throw.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
  - 5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. Shop Drawings: For each type of enclosed switch and circuit breaker. Include plans, elevations, sections and details.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
  - 2. Include wiring diagrams for power, signal, and control wiring.
- C. Comprehensive Product Data and Shop Drawing Submittal Package: Submit product data and shop drawing information for all items specified under this Section in a single comprehensive Product Data and Shop Drawing Submittal Package. This Submittal Package shall contain only items specified under, or directly related to, this Section. Submittals that do not include each specified unit or contains incomplete submittal information will be rejected.
- D. Qualification Data: For qualified testing agency.
- E. Field quality-control reports.

- F. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
  - 2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include 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 NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- C. 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.
- D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- E. Comply with NFPA 70.

### **1.6 PROJECT CONDITIONS**

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
  - 2. Altitude: Not exceeding 6600 feet.

### **1.7 COORDINATION**

- A. Coordinate layout and installation of switches, circuit breakers, 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.

### **1.8 EXTRA MATERIALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  - 2. Fuse Pullers: One for each size and type.

## **PART 2 - PRODUCTS**

### **2.1 FUSIBLE AND NON-FUSIBLE SWITCHES**

- A. Manufacturers: Provide products by Square D; a brand of Schneider Electric. or approved equivalent.
- 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.
  - 1. Short-Circuit Current Rating: 200kA when equipped with J, L or R fuses

- C. Non-fusible 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.
  - 1. Short-Circuit Current Rating: 200kA when protected by upstream J, L or R fuses.
- 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; labeled for copper and aluminum neutral conductors.
  - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  - 4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contacts, arranged to activate before switch blades open.
  - 5. Hookstick Handle: Allows use of a hookstick to operate the handle.
  - 6. Lugs: Mechanical type, suitable for number, size, and conductor material.

## 2.2 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Provide products by Square D; a brand of Schneider Electric. or approved equivalent.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Comply with UL 489 with interrupting capacity to comply with available fault currents.
- D. 250A frame or Smaller: Thermal-magnetic circuit breaker; 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 125 A and larger.
- E. Larger than 250A frame: Electronic trip circuit breaker; field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
  - 1. Instantaneous trip.
  - 2. Long- and short-time pickup levels.
  - 3. Long- and short-time time adjustments.
  - 4. Ground-fault pickup level, time delay, and  $I^2t$  response.
- F. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- G. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- H. Features and Accessories:
  - 1. Standard frame sizes, trip ratings, and number of poles.
  - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
  - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
  - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
  - 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

6. 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.
7. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
8. Accessory Control Power Voltage: Integrally mounted, self-powered.

### **2.3 MOLDED-CASE SWITCHES**

- A. Manufacturers: Provide products by Square D; a brand of Schneider Electric. or approved equivalent.
- B. General Requirements: Molded-case circuit breaker type with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Comply with UL 489 with interrupting capacity to comply with available fault currents.
- D. Features and Accessories:
  1. Standard frame sizes and number of poles.
  2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
  3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
  4. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.

### **2.4 ENCLOSURES**

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
  1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  2. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
  3. Outdoor Locations: NEMA 250, Type 3R.
  4. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
  5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
- B. Enclosure Finish:
  1. NEMA 250, Type 1: Gray baked enamel paint, electrodeposited on cleaned, phosphatized steel
  2. NEMA 250, Type 3R and 12: Gray baked enamel paint, electrodeposited on cleaned, phosphatized galvanized steel
  3. NEMA 250, Type 4 and 4X: Brush finish on Type 304 stainless steel.
- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.



### **3.2 CONCRETE BASES**

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.

### **3.3 INSTALLATION**

- A. Comply with applicable portions of NECA 1, NEMA PB 1.1, and NEMA PB 2.1 for installation of enclosed switches and circuit breakers.
- B. Mount individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated. Anchor floor-mounting switches to concrete base.
- C. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in fusible devices.
- F. Comply with NFPA 70 and NECA 1.

### **3.4 IDENTIFICATION**

- A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

### **3.5 FIELD QUALITY CONTROL**

- A. Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Tests and Inspections for Switches:
  - 1. Visual and Mechanical Inspection:
    - a. Inspect physical and mechanical condition.
    - b. Inspect anchorage, alignment, grounding, and clearances.
    - c. Verify that the unit is clean.
    - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
    - e. Verify that fuse sizes and types match the Specifications and Drawings.
    - f. Verify that each fuse has adequate mechanical support and contact integrity.
    - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
      - 1) Use a low-resistance ohmmeter.
        - a. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

- a. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
  - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
  - i. Verify correct phase barrier installation.
  - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
- 2. Electrical Tests:
  - a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - b. Measure contact resistance across each switchblade fuse-holder. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
  - d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
  - e. Perform ground fault test according to NETA ATS 7.14 "Ground Fault Protection Systems, Low-Voltage."
- C. Tests and Inspections for Molded Case Circuit Breakers:
  - 1. Visual and Mechanical Inspection:
    - a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
    - b. Inspect physical and mechanical condition.
    - c. Inspect anchorage, alignment, grounding, and clearances.
    - d. Verify that the unit is clean.
    - e. Operate the circuit breaker to ensure smooth operation.
    - f. Inspect bolted electrical connections for high resistance using one of the two following methods:
      - 1) Use a low-resistance ohmmeter.
        - a. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
      - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.

- a. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
  - g. Inspect operating mechanism, contacts, and chutes in unsealed units.
  - h. Perform adjustments for final protective device settings in accordance with the coordination study.
2. Electrical Tests:
- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use Table 100.1 from the NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
  - c. Perform a contact/pole resistance test. Drop values shall not exceed the high level of the manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - d. Perform insulation resistance tests on all control wiring with respect to ground. Applied potential shall be 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable. Test duration shall be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values shall be no less than two megohms.
  - e. Determine the following by primary current injection:
    - 1) Long-time pickup and delay. Pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 2) Short-time pickup and delay. Short-time pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 3) Ground-fault pickup and time delay. Ground-fault pickup values shall be as specified. Trip characteristics shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
    - 4) Instantaneous pickup. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances.
  - f. Test functionality of the trip unit by means of primary current injection. Pickup values and trip characteristics shall be as specified and within manufacturer's published tolerances.
  - g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of the shunt trip and close coils shall be as indicated by manufacturer.
  - h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset all trip logs and indicators. Investigate units that do not function as designed.

- i. Verify operation of charging mechanism. Investigate units that do not function as designed.
3. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
4. 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 enclosed switch and circuit breaker. 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 enclosed switch and circuit breaker 11 months after date of Substantial Completion.
  - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
5. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above. Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### **3.6 ADJUSTING**

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges.

### **3.7 CLEANING**

- A. On completion of installation, vacuum dirt and debris from interiors; do not use compressed air to assist in cleaning.
- B. Inspect exposed surfaces and repair damaged finishes.

END OF SECTION

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## **SECTION 26 29 13 - ENCLOSED MOTOR CONTROLLERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes the following enclosed controllers rated 600 V and less:
  - 1. Full-voltage manual.
  - 2. Full-voltage magnetic.
  - 3. Multi-speed.
  - 4. Reduced-voltage solid state.
- B. Related Section:
  - 1. Division 26 Section "Variable-Frequency Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on variable torque loads in ranges up to 200 hp.

#### **1.3 DEFINITIONS**

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. NC: Normally closed.
- E. NO: Normally open.
- F. OCPD: Overcurrent protective device.
- G. SCR: Silicon-controlled rectifier.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.
- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
  - 1. Show tabulations of the following:
    - a. Each installed unit's type and details.
    - b. Factory-installed devices.
    - c. Nameplate legends.
    - d. Short-circuit current rating of integrated unit.
    - e. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
  - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Comprehensive Product Data and Shop Drawing Submittal Package: Submit product data and shop drawing information for all items specified under this Section in a single comprehensive Product Data and Shop Drawing Submittal Package. This Submittal Package shall contain only

items specified under, or directly related to, this Section. Submittals that do not include each specified unit or contains incomplete submittal information will be rejected.

- D. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- E. Field quality-control reports.
- F. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Routine maintenance requirements for enclosed controllers and installed components.
  - 2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
  - 3. Manufacturer's written instructions for setting field-adjustable overload relays.
  - 4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.
- G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

#### **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 NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- B. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.
- C. 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.
- D. Comply with NFPA 70.
- E. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed controllers, minimum clearances between enclosed controllers, and for adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

#### **1.7 PROJECT CONDITIONS**

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
  - 2. Altitude: Not exceeding 6600 feet.

#### **1.8 COORDINATION**

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1. Do not install enclosed controllers below wet piped systems. If unavoidable, install protective shields to deflect leaks away from enclosed controller.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
- D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

## **1.9 EXTRA MATERIALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  3. Indicating Lights: Two of each type and color installed.
  4. Auxiliary Contacts: Furnish one spares for each size and type of magnetic controller installed.
  5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Provide products by Square D; a brand of Schneider Electric. or approved equivalent.

### **2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS**

- A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."
  1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.
- B. Magnetic Controller: NEMA ICS 2, Class A, full-voltage, non-reversing, across-the-line, unless otherwise indicated.
  1. Control Circuit: 120 V; obtained from integral control power transformer with a control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
  2. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- C. Combination Magnetic Controller: Factory-assembled combination controller and disconnect switch.

1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.

### **2.3 MULTI-SPEED ENCLOSED CONTROLLERS**

- A. Multi-speed Enclosed Controller: Match controller to motor type, application, and number of speeds; include the following accessories:
  1. Compelling relay to ensure that motor will start only at low speed.
  2. Accelerating relay to ensure properly timed acceleration through speeds lower than that selected.
  3. Decelerating relay to ensure automatically timed deceleration through each speed.

### **2.4 REDUCED-VOLTAGE SOLID-STATE CONTROLLERS**

- A. General Requirements for Reduced-Voltage Solid-State Controllers: Comply with UL 508.
- B. Reduced-Voltage Solid-State Controllers: An integrated unit with power SCRs, heat sink, microprocessor logic board, door-mounted digital display and keypad, bypass contactor, and overload relay; suitable for use with NEMA MG 1, Design B, poly-phase, medium induction motors.
  1. Configuration: Standard duty; nonreversible.
  2. Starting Mode: Voltage ramping, current limit, torque control, and torque control with voltage boost; field selectable.
  3. Stopping Mode: Coast to stop, adjustable torque deceleration, and adjustable braking; field selectable.
  4. Shorting (Bypass) Contactor: Operates automatically when full voltage is applied to motor, and bypasses the SCRs. Solid-state controller protective features shall remain active when the shorting contactor is in the bypass mode.
  5. Shorting and Input Isolation Contactor Coils: Pressure-encapsulated type; manufacturer's standard operating voltage, matching control power or line voltage, depending on contactor size and line-voltage rating. Provide coil transient suppressors.
  6. Logic Board: Identical for all ampere ratings and voltage classes, with environmental protective coating.
  7. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
    - a. CPT Spare Capacity: 100 VA.
  8. Adjustable acceleration-rate control using voltage or current ramp, and adjustable starting torque control with up to 400 percent current limitation for 20 seconds.
  9. SCR bridge shall consist of at least two SCRs per phase, providing stable and smooth acceleration without external feedback from the motor or driven equipment.
  10. Keypad, front accessible; for programming the controller parameters, functions, and features; shall be manufacturer's standard and include not less than the following functions:
    - a. Adjusting motor full-load amperes, as a percentage of the controller's rating.
    - b. Adjusting current limitation on starting, as a percentage of the motor full-load current rating.
    - c. Adjusting linear acceleration and deceleration ramps, in seconds.
    - d. Initial torque, as a percentage of the nominal motor torque.



- e. Adjusting torque limit, as a percentage of the nominal motor torque.
  - f. Adjusting maximum start time, in seconds.
  - g. Adjusting voltage boost, as a percentage of the nominal supply voltage.
  - h. Selecting stopping mode, and adjusting parameters.
  - i. Selecting motor thermal overload protection class between 5 and 30.
  - j. Activating and de-activating protection modes.
  - k. Selecting or activating communication modes.
11. Digital display, front accessible; for showing motor, controller, and fault status; shall be manufacturer's standard and include not less than the following:
- a. Controller Condition: Ready, starting, running, stopping.
  - b. Motor Condition: Amperes, voltage, power factor, power, and thermal state.
  - c. Fault Conditions: Controller thermal fault, motor overload alarm and trip, motor under-load, overcurrent, shorted SCRs, line or phase loss, phase reversal, and line frequency over or under normal.
12. Controller Diagnostics and Protection:
- a. Microprocessor-based thermal protection system for monitoring SCR and motor thermal characteristics, and providing controller over-temperature and motor-overload alarm and trip; settings selectable via the keypad.
  - b. Protection from line-side reverse phasing; line-side and motor-side phase loss; motor jam, stall, and under-load conditions; and line frequency over or under normal.
  - c. Input isolation contactor that opens when the controller diagnostics detect a faulted solid-state component or when the motor is stopped.
  - d. Shunt trip that opens the disconnecting means when the controller diagnostics detect a faulted solid-state component.
13. Remote Output Features:
- a. All outputs prewired to terminal blocks.
  - b. Form C status contacts that change state when controller is running.
  - c. Form C alarm contacts that change state when a fault condition occurs.
14. Optional Features:
- a. Analog output for field-selectable assignment of motor operating characteristics; 4 to 20-mA dc.
  - b. Additional field-assignable Form C contacts, as indicated, for alarm outputs.
  - c. Surge suppressors in solid-state power circuits providing three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
  - d. Isolated overload alarm contact.
  - e. External overload reset push button.
- C. Combination Reduced-Voltage Solid-State Controller: Factory-assembled combination of reduced-voltage solid-state controller, OCPD, and disconnecting means.
- 1. Fusible Disconnecting Means:

- a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate associated fuses.
- b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

## 2.5 ENCLOSURES

- A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
  - 1. Outdoor Locations: NEMA 250, Type 3R.
  - 2. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
  - 3. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
  - 4. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

## 2.6 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.
- C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- D. Control Relays: Auxiliary and adjustable time-delay relays.
- E. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- F. Elapsed Time Meters: Heavy duty with digital readout in hours.
- G. Phase-Failure and Under-voltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connection. Provide adjustable under-voltage setting.

## 2.7 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and space conditions for compliance with requirements for motor controllers, their relationship with the motors, and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLICATIONS

- A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.

### 3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

- C. Floor-Mounted Controllers: Install controllers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Division 03 Section "Cast-in-Place Concrete."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.
- F. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- G. Setting of Overload Relays: Select and set overloads on the basis of full-load current rating as shown on motor nameplate. Adjust setting value for special motors as required by NFPA 70 for motors that are high-torque, high-efficiency, and so on.

### **3.4 IDENTIFICATION**

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved nameplate.
  - 3. Label each enclosure-mounted control and pilot device.

### **3.5 CONTROL WIRING INSTALLATION**

- A. Install wiring between enclosed controllers and remote devices and facility's central control system. Comply with requirements in Division 26 Section "Low-Voltage Cables and Conductors."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.
  - 1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
  - 2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### **3.6 CONNECTIONS**

- A. Ground equipment according to Division 26 Section "Grounding and Bonding."

### **3.7 FIELD QUALITY CONTROL**

- A. Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Tests and inspections:
- C. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- D. Tests and Inspections:
  - 1. Inspect controllers, wiring, components, connections, and equipment installation.
  - 2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.

3. Test continuity of each circuit.
  4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager Owner before starting the motor(s).
  5. Test each motor for proper phase rotation.
  6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Enclosed controllers will be considered defective if they do not pass tests and inspections.
  - F. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### **3.8 ADJUSTING**

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.
- D. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.
- E. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Electrical Studies and Settings."

### **3.9 PROTECTION**

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

### **3.10 DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

END OF SECTION 26 29 13

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## **SECTION 26 29 23 - VARIABLE FREQUENCY CONTROLLERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes separately enclosed, pre-assembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.
- B. Related Sections include the following:
  - 1. Division 23 Section "HVAC Instrumentation and Controls" for integration of variable frequency controllers to building automation system.

#### **1.3 DEFINITIONS**

- A. BAS: Building automation system.
- B. CPT: Control power transformer.
- C. EMI: Electromagnetic interference.
- D. IGBT: Integrated gate bipolar transistor.
- E. LAN: Local area network.
- F. PID: Control action, proportional plus integral plus derivative.
- G. PWM: Pulse-width modulated.
- H. RFI: Radio-frequency interference.
- I. TDD: Total demand (harmonic current) distortion.
- J. THD(V): Total harmonic voltage demand.
- K. VFC: Variable frequency controller.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of VFC. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.
- B. Shop Drawings: For each VFC.
  - 1. Include 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. Each installed unit's type and details.
    - b. Nameplate legends.
    - c. Short-circuit current rating of integrated unit.
  - 2. Wiring Diagrams: Power, signal, and control wiring for VFCs. Provide schematic wiring diagram for each type of VFC.
  - 3. BAS Interconnection: Show detailed information regarding network interconnections between VFCs and building automation system, including coordinated network protocol and

necessary communications transmission pathways to be utilized. Clearly document that BAS interconnections have been coordinated.

4. Points List: Provide a comprehensive points list for each component to be interconnected to the BAS. Clearly identify points that will be controlled and monitored by the BAS.
- C. Harmonic Distortion Analysis Study and Report: Comply with IEEE 399 and NETA Acceptance Testing Specification; identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Generate report documenting harmonic distortion analysis for voltage distortion (THDv) and current distortion (TDD) due to VFCs, and submit as part of overall VFC submittal package. Analysis shall account for quantity and location of all VFCs, and shall be based on actual worst-case system conditions. Analysis shall clearly show that selected methods of harmonic mitigation result in harmonic levels that do not exceed those specified. Include the following:
1. Input data.
  2. Method used for calculations.
  3. Calculations performed at each point of coupling:
    - a. At the point where each VFC connects to power system.
    - b. At each bus that powers one or more VFCs.
    - c. At main buses (normal and alternate power) serving systems that include VFCs.
- D. Comprehensive Product Data and Shop Drawing Submittal Package: Submit product data and shop drawing information for all items specified under this Section in a single comprehensive Product Data and Shop Drawing Submittal Package. Package shall include Harmonic Distortion Analysis. Submittals that do not include each specified unit or contains incomplete submittal information will be rejected.
- E. Harmonic Distortion Field Test Report: Provide harmonic distortion field testing on installed system by an independent testing agency showing that system meets harmonic distortion limits specified. Provide final test report that includes the measured voltage and current distortion levels at each point of coupling.
- F. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFCs where pipe and ducts are prohibited. Show VFC layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.
- G. Qualification Data: For manufacturer and testing agency.
- H. Field quality-control test reports.
- I. Operation and Maintenance Data: For VFCs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Routine maintenance requirements for VFCs and all installed components.
  2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- J. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

## **1.5 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

- B. Factory Testing: Fully test VFC and associated features for proper operation prior to delivery to site. Provide 24-hour burn-in of each VFC unit.
- 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) 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.
- D. Source Limitations: Obtain VFCs of a single type 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 NFPA 70.
- G. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFCs, minimum clearances between VFCs, and adjacent surfaces and other items. Comply with indicated maximum dimensions and clearances.

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver VFCs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.
- B. Store VFCs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFCs from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- C. If stored in areas subject to weather, cover VFCs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

## **1.7 PROJECT CONDITIONS**

- A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:
  - 1. Ambient Temperature: 0 to 40 deg C.
  - 2. Humidity: Less than 90 percent (non-condensing).
  - 3. Altitude: Not exceeding 3300 feet.

## **1.8 COORDINATION**

- A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:
  - 1. Torque, speed, and horsepower requirements of the load.
  - 2. Ratings and characteristics of supply circuit and required control sequence.
  - 3. Ambient and environmental conditions of installation location.
- B. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
  - 1. Do not install VFCs below wet piped systems. If unavoidable, install protective shields to deflect leaks away from VFC.

- C. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."
- D. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."
- E. Coordinate features of VFCs, installed units, and accessory devices with pilot devices and control circuits to which they connect.
- F. Coordinate features, accessories, and functions of each VFC and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.
- G. Coordinate interconnections with the BAS and provide required field support to demonstrate that equipment under this Section is properly reporting at the front-end of the building automation system.

### **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. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
  - 2. Indicating Lights: Two of each type installed.

### **1.10 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:
  - 1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
  - 2. Danfoss Inc.; Danfoss Electronic Drives Div.
  - 3. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
  - 4. Yaskawa Electric America, Inc.

### **2.2 VARIABLE FREQUENCY CONTROLLERS**

- A. General Requirements for VFCs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
- B. Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
  - 1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."



2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
  3. Units suitable for operation of premium-efficiency motor as defined by NEMA MG 1.
  4. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- C. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- D. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
- E. Short-Circuit Rating: Minimum rating of 65kA rms (100kA rms with DC bus reactor) without supplementary input fusing.
- F. Unit Operating Requirements:
1. Input AC Voltage Tolerance: Plus/minus 10 percent of VFC input voltage rating.
  2. Input AC Voltage Unbalance: Not exceeding 5 percent.
  3. Input Frequency Tolerance: Plus/minus 3 percent of VFC frequency rating.
  4. Minimum Efficiency: 96 percent at 60 Hz, full load.
  5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
  6. Vibration Withstand: Comply with IEC 60068-2-6.
  7. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
  8. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
  9. Speed Regulation: Plus/minus 1 percent.
  10. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
  11. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.
- H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.
1. Signal: Electrical.
- I. Internal Adjustability Capabilities:
1. Minimum Speed: 5 to 50 percent of maximum rpm.
  2. Maximum Speed: 50 to 100 percent of maximum rpm.
  3. Acceleration: 0.1 to a minimum of 999.9 seconds.
  4. Deceleration: 0.1 to a minimum of 999.9 seconds with over-ride circuit to prevent nuisance tripping if deceleration time is too short.
  5. Current Limit: 30 to a minimum of 150 percent of maximum rating.
- J. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
  2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.

3. Under- and overvoltage trips.
  4. DC bus over-voltage.
  5. Inverter overcurrent trips.
  6. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
  7. Critical frequency rejection, with three selectable, adjustable deadbands.
  8. Instantaneous line-to-line and line-to-ground overcurrent trips.
  9. Loss-of-phase protection.
  10. Reverse-phase protection.
  11. Short-circuit protection.
  12. Motor overtemperature fault.
- K. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.
- L. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional auto-speed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.
- M. Bidirectional Autospeed Search: Capable of starting VFC into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- N. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- O. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- P. Integral Disconnecting Means and OCPD: Door-interlocked, NEMA KS 1 fusible switch, with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
  2. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
  3. Integral Disconnect Fuses: Class J, L or R; dual-element, time-delay, current-limiting, selected to ensure that associated downstream non-fused motor disconnects and safety switches are applied within their short-circuit current rating. Fuses must be located upstream of bypass take-off.
- Q. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault.
- R. DC Bus Discharge: Circuit for discharging DC bus.

### **2.3 CONTROLS AND INDICATION**

- A. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
1. Power on.
  2. Run.
  3. Over-voltage.

4. Line fault.
  5. Overcurrent.
  6. External fault.
- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
  2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.
    - a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.
- C. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
  2. Running log of total power versus time.
  3. Total run time.
  4. Fault log, maintaining last four faults with time and date stamp for each.
- D. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
1. Output frequency (Hz).
  2. Motor speed (rpm).
  3. Motor status (running, stop, fault).
  4. Motor current (amperes).
  5. Motor torque (percent).
  6. Fault or alarming status (code).
  7. PID feedback signal (percent).
  8. DC-link voltage (VDC).
  9. Set-point frequency (Hz).
  10. Motor output voltage (V).
- E. Control Signal Interface:
1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
  2. Remote Signal Shutdown: A minimum of two inputs for safety interlocks such as freeze and smoke shutdown.
  3. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
    - a. 0 to 10-V dc.
    - b. 0-20 or 4-20 mA.
    - c. Potentiometer using up/down digital inputs.

- d. Fixed frequencies using digital inputs.
  - e. RS485.
  - f. Keypad display for local hand operation.
4. Output Signal Interface:
- a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
    - 1) Output frequency (Hz).
    - 2) Output current (load).
    - 3) DC-link voltage (VDC).
    - 4) Motor torque (percent).
    - 5) Motor speed (rpm).
    - 6) Set-point frequency (Hz).
5. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
- a. Motor running.
  - b. Set-point speed reached.
  - c. Fault and warning indication (over-temperature or overcurrent).
  - d. PID high- or low-speed limits reached.

F. Communications

1. The VFC shall have an RS-485 port as standard. The standard protocols shall be Modbus, Johnson Controls N2 bus, and Siemens Building Technologies FLN. Optional protocols for LonWorks, BACnet, Profibus, Ethernet, and DeviceNet shall be available. Each individual drive shall have the protocol in the base VFC. 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.
2. The BACnet connection shall be an RS485, MSTP interface operating at 9.6, 19.2, 38.4, or 76.8 Kbps. The connection shall be tested by the BACnet Testing Labs (BTL) and be BTL Listed. The BACnet interface shall conform to the BACnet standard device type of an Applications Specific Controller (B-ASC). The interface shall support all BIBBs defined by the BACnet standard profile for a B-ASC including, but not limited to:
  - a. Data Sharing – Read Property – B.
  - b. Data Sharing – Write Property – B.
  - c. Device Management – Dynamic Device Binding (Who-Is; I-AM).
  - d. Device Management – Dynamic Object Binding (Who-Has; I-Have).
  - e. Device Management – Communication Control – B.
  - f. If additional hardware is required to obtain the BACnet interface, the VFC manufacturer shall supply one BACnet gateway per drive. Multiple VFCs sharing one gateway shall not be acceptable.
3. 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 VFC 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 VFC 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 VFC mode or bypass mode (if bypass is specified) over serial communications. A minimum of 15 field parameters shall be capable of being monitored.

4. The VFC shall allow the DDC to control the drive’s digital and analog outputs via the serial interface. This control shall be independent of any VFC 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.
  5. The VFC 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 VFC control PID loop and the independent PID loop shall continue functioning even if the serial communications connection is lost. The VFC 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.
- G. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status, alarms and energy usage. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC's nonvolatile memory.
1. Network Communications Ports: Ethernet and RS-422/485.
  2. Embedded BAS Protocols for Network Communications: Same as BAS; protocols accessible via the communications ports.

## **2.4 LINE CONDITIONING AND FILTERING**

- A. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD at input terminals of all VFCs to less than 5 percent and THD(V) to 5 percent, at any load level. No individual harmonic shall exceed 3 percent distortion.
- B. Minimum Conditioning Requirements: Independent of anticipated harmonic levels calculated in the harmonic study and analysis, minimum harmonic mitigation methods shall be no less than the following:
1. Units Less Than 25 HP: 6-pulse rectifier with 3-percent input line reactor and DC bus reactor.
  2. Units 25 HP and larger: Active front end (IGBT rectifier) with integral EMI/RFI filter.
- C. Additional Conditioning Requirements: In addition to units described above, provide active front end drives for units specifically indicated elsewhere in the Documents. Review the documents of other trades to determine the full extent of active front end drives required for the Project.
- D. VFC Output Filtering: Provide dv/dt filter for VFC output cable lengths longer than 80-feet.
- E. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

## **2.5 BYPASS SYSTEMS**

- A. Provide for all units where only one motor is controlled by VFC.

- B. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
- C. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.
- D. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.
  - 1. Bypass Contactor: Load-break, NEMA-rated contactor.
  - 2. Input and Output Isolating Contactors: Non-load-break, NEMA-rated contactors.
  - 3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
- E. Bypass Contactor Configuration: Full-voltage (across-the-line) for units rated less than 50hp; reduced-voltage (solid-state) type for units 50hp and greater.
  - 1. NORMAL/BYPASS selector switch.
  - 2. HAND/OFF/AUTO selector switch.
  - 3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
  - 4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.
    - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
    - b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
  - 5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
    - a. CPT Spare Capacity: 100 VA.
    - b. Solid-State Overload Relays:
      - 1) Switch or dial selectable for motor-running overload protection.
      - 2) Sensors in each phase.
      - 3) Class 10 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
      - 4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
    - c. Isolated overload alarm contact.
    - d. External overload reset push button.

## 2.6 REDUNDANT MANUAL AND AUTO DRIVE BYPASS

- A. Provide for all units where multiple motors are served by single VFC, such as air handler fan arrays.
- B. VFC and VFC bypass components shall be mounted inside a common NEMA 1 enclosure, fully pre-wired, and ready for installation as a single UL listed device. Bypass shall include the following:
  - 1. Input drive 1, output drive 1, input drive 2, and output drive 2 contactors, to disconnect power to one of the drives, when the motor is running in either drive 1 or drive 2 mode.
  - 2. 120 VAC control transformer, with fused primary.
  - 3. Fused input disconnect switch, with a pad-lockable through-the-door handle mechanism.
  - 4. Control and safety circuit terminal strip.
  - 5. Drive 1 / Drive 2 selector switch, Hand/Off/Auto selector switch, Normal/Test Drive and Drive 2 selector switch
  - 6. Test Drive 1/Normal/Test Drive 2 selector switch, shall allow testing and adjustment of Either Drive, while the motor is running with opposite drive.
  - 7. Hand/Off/Auto selector switch shall provide the following operation:
    - a. Hand Position - The drive is given a start command, operation is via the local speed input (digital operator).
    - b. Off Position - The start command is removed, all speed inputs are ignored, power is still applied to the drive.
    - c. Auto Position - The drive is enabled to receive a start command and speed input from a building automation system.
  - 8. Drive 1/Auto/Drive 2 selector switch shall provide the following operation:
    - a. Drive 1 – Drive 1 is selected and responds to H/O/A switch.
    - b. Auto – Drive 1 or Drive 2 is selected via contact closure from the building automation system and responds to the H/O/A switch.
    - c. Drive 2 – Drive 2 is selected and responds to H/O/A switch.
  - 9. Annunciation contacts for drive 1 run, drive 1 fault, drive 2 run, drive 2 fault and safety fault.
  - 10. Damper control circuit with end of travel feedback capability.
  - 11. VFC operator/keypad selection, LCD.
  - 12. Auto transfer from either Drive to opposite Drive if a fault occurs. This transfer must be bumpless. Transfer occurs when in the Auto mode only and responds to a Drive Fault or loss of drive input power do to a blown fuse at the drive input.

## 2.7 ENCLOSURES

- A. NEMA 250, to comply with environmental conditions at installed location:
  - 1. Dry and Clean Indoor Locations: Type 12.
  - 2. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.
  - 3. Outdoor Locations: Type 3R.
  - 4. Kitchen Areas: Type 4X, stainless steel.
  - 5. Wash-Down Areas: Type 4X, stainless steel.

6. Other Wet or Damp Indoor Locations: Type 4.

- B. Plenum Rating: For units to be installed in plenums or in other spaces used for environmental air, comply with UL 1995; provide NRTL certification label on enclosure, clearly identifying VFC as "Plenum Rated."

## **2.8 ACCESSORIES**

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.
  - a. Push Buttons, Pilot Lights, and Selector Switches: Heavy -duty, oiltight type.
  - b. Push Buttons: Lockable types; maintained.
  - c. Pilot Lights: LED types; push to test.
  - d. Selector Switches: Rotary type.
  - e. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- B. Reversible NC/NO bypass contactor auxiliary contacts.
- C. Control Relays: Auxiliary and adjustable time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
- E. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.
- F. Supplemental Digital Meters:
  - 1. Elapsed-time meter.
  - 2. Kilowatt meter.
  - 3. Kilowatt-hour meter.
- G. Space heaters, with NC auxiliary contacts, to mitigate condensation in enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.
- H. Spare control-wiring terminal blocks; unwired.

## **2.9 FACTORY FINISHES**

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VFCs before shipping.

## **2.10 SOURCE QUALITY CONTROL**

- A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2.
  - 1. Test each VFC while connected to its specified motor.
  - 2. Verification of Performance: Rate VFCs according to operation of functions and features specified.
- B. VFCs will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.



## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas, surfaces, and substrates to receive VFCs, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance.
- B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFC installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 HARMONIC ANALYSIS STUDY**

- A. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze possible operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFC, and each defined PCC, to specified levels.
- B. Prepare a harmonic analysis study and report complying with IEEE 399 and NETA Acceptance Testing Specification.

### **3.3 APPLICATIONS**

- A. Select features of each VFC to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.
- B. Select horsepower rating of controllers to suit motor controlled.

### **3.4 INSTALLATION**

- A. Coordinate layout and installation of VFCs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- C. Floor-Mounting Controllers: Install VFCs on 4-inch nominal thickness concrete base. Comply with requirements for concrete base specified in Division 03 Section "Cast-in-Place Concrete."
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  - 2. For supported equipment, 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 supported equipment.
- D. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.
  - 1. Curbs and roof penetrations are specified in Division 07 Section "Roof Accessories."
  - 2. Structural-steel channels are specified in Division 26 Section "Hangers and Supports for Electrical Systems."

- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- F. Install fuses in each fusible-switch VFC.
- G. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."
- H. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- I. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- J. Comply with NECA 1.

### **3.5 CONCRETE BASES**

- A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.
- B. Concrete base materials and installation requirements are specified in Division 03.

### **3.6 IDENTIFICATION**

- A. Identify VFCs, components, and control wiring according to Division 26 Section "Electrical Identification."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each VFC with engraved nameplate.
  - 3. Label each enclosure-mounted control and pilot device.
- B. Operating Instructions: Frame printed operating instructions for VFCs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFC units.

### **3.7 CONTROL WIRING INSTALLATION**

- A. Install wiring between VFCs and remote devices according to Division 26 Section "Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
  - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
  - 2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### **3.8 CONNECTIONS**

- A. Ground equipment according to Division 26 "Grounding and Bonding."

### **3.9 FIELD QUALITY CONTROL**

- A. Prepare for acceptance tests as follows:
  - 1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
  - 1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
  - 2. Assist in field testing of equipment.
  - 3. Report results in writing.
- C. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:
  - 1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. 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.

### **3.10 ADJUSTING**

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

### **3.11 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency controllers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

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## **SECTION 26 32 13 - ENGINE GENERATORS**

### **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 emergency and standby power supply with the following features:
  - 1. Natural Gas Vapor engine.
  - 2. Unit-mounted cooling system.
  - 3. Generator control and monitoring.
  - 4. Performance requirements for sensitive loads.
  - 5. Sound-attenuated outdoor enclosure.
- B. Related Sections include the following:
  - 1. Division 23 Sections relating to "Building Automation System" for network interfaces and protocols, and sequences of operation.
  - 2. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.
  - 3. Division 26 Section "Electrical Studies and Settings" for selective coordination study.

#### **1.3 DEFINITIONS**

- A. BAS: Building Automation System.
- B. EPS: Emergency power supply.
- C. EPSS: Emergency power supply system.
- D. 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.

#### **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 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.
  - 5. Over-current protection, relays and control devices shall be identified and their ratings marked.
  - 6. Electrical schematic drawings shall be provided to detail the operation of the load bank and the provided safety circuits. A system interconnection drawing shall be included for control wiring related to the load bank.
  - 7. Noise Emissions: Provide a submittal with suitably supported and documented noise emission calculations or measurement data to demonstrate compliance with noise levels

- outlined in the specification. The submittal shall ensure all aspects of noise emission from the unit have been included.
8. Copy of blank NFPA 110 Acceptance Test form for review.
  9. BAS Interconnection: Show detailed information regarding network interconnections between generators and building automation system, including coordinated network protocol and necessary communications transmission pathways to be utilized. Clearly document that BAS interconnections have been coordinated.
  10. Points List: Provide a comprehensive points list for each component to be interconnected to the BAS. Clearly identify points that will be monitored by the BAS.
- C. Comprehensive Product Data and Shop Drawing Submittal Package: Submit product data and shop drawing information for all items specified under this Section in a single comprehensive Product Data and Shop Drawing Submittal Package. Submittals that do not include each specified unit or contain incomplete submittal information will be rejected.
- D. Qualification Data: For manufacturer and testing agency.
- E. 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.
- F. Field quality-control test reports.
- G. 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 being stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
- H. 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 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 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 110 requirements for Level 1 emergency power supply system.
- J. Comply with UL 2200.
- K. Engine Exhaust Emissions: Comply with applicable state and local government requirements.
- L. Engine Exhaust Emissions Certification: U.S. EPA Tier 2-certified, unless EPA Tier 3-certification required based on actual engine size provided.
- M. Noise Emission: Comply with applicable state and local government requirements for maximum allowable noise levels 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. 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 C.
  2. Altitude: Sea level to 1000 feet.

## **1.7 COORDINATION**

- A. Coordinate size and location of concrete bases for package engine generators and remote load bank mounted on grade. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate interconnections with the BAS and provide required field support to demonstrate that equipment under this Section is properly reporting at the front-end of the building automation system.

## **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. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equivalent:

1. Onan/Cummins Power Generation.
2. Caterpillar; Engine Div.
3. MTU, Onsite Energy.

## **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. Output rating shall be as indicated after all de-rating factors have been applied, including those for emissions controls.
  2. Output Connections: Three-phase, four-wire.
  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. 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: Natural Gas.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

- 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. Electronic Pressure Regulator: Regulates the fuel mixture based on Intake Air Temperature, Load, Etc.
  2. ECU: Coupled into the generator set control panel interface to allow direct control from the panel.
  3. System Control: Closed Loop fuel system using readings from O2 sensor(s) to maintain proper fuel mixture through control of the Electronic Pressure Regulator.
- 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: 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. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
  4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
    - a. Rating: 50-psi maximum working pressure with coolant at 180 deg F, and non-collapsible under vacuum.
    - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- I. Muffler/Silencer: Critical type with flexible steel pipe connector, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements. Utilize barrel type muffler; pancake type not permitted.
1. Minimum sound attenuation of 30 dB at 500 Hz.
  2. Muffler/silencer shall be mounted within generator enclosure. Sound level outside enclosure shall meet the criteria specified in OUTDOOR GENERATOR-SET ENCLOSURE.
- J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- K. Starting System: 24-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 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. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.
- C. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, 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 switches.
  9. Generator-voltage adjusting rheostat.
  10. Generator overload.
- D. 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.
- E. 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 data-link transmission of indications to remote data terminals.

- F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.
  - 1. Over-crank shutdown.
  - 2. Coolant low-temperature alarm.
  - 3. Control switch not in auto position.
  - 4. Battery-charger malfunction alarm.
  - 5. Battery low-voltage alarm.
- G. Remote Alarm Annunciator: 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.
- H. Remote Emergency-Stop Switch: Flush; mounted within generator enclosure, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

## 2.5 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Overcurrent protective devices for the entire EPSS shall be coordinated to optimize selective tripping when a short circuit occurs. Coordination of protective devices shall consider both utility and EPSS as the voltage source.
  - 1. Overcurrent protective devices for the EPSS shall be accessible only to authorized personnel.
- B. Generator Circuit Breakers: Insulated-case, electronic-trip type; 100-percent rated; complying with UL 489. Circuit breakers dedicated for load banking use may be thermal-magnetic type, with no metering or monitoring functions required.
  - 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. Electronic Trip Units: Full-function, microprocessor-based trip units with trip indicators and the following features and accessories:
  - 1. Fully-programmable, field-adjustable settings:
    - a. Instantaneous trip.
    - b. Long- and short-time pickup levels.
    - c. Long- and short-time time adjustments.
    - d. Ground-fault (alarm only for emergency units.)
  - 2. Metering and Monitoring:
    - a. Circuit breaker status (open, closed, tripped.)
- D. 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 performs 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. Contacts shall be available for load shed functions.
  - 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.

- E. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

## **2.6 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, over-speed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- F. Enclosure: Drip-proof.
- G. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
  - 1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 10 percent adjustment of output-voltage operating band.
- H. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- J. Subtransient Reactance: 11 percent maximum at 125 deg C.

## **2.7 OUTDOOR GENERATOR-SET ENCLOSURE**

- A. Description: Prefabricated or pre-engineered enclosure with the following features:
  - 1. Construction: Vandal-resistant, sound-attenuated, weatherproof galvanized-steel, metal-clad, custom-fabricated integral structural-steel framed building erected on concrete foundation. Multiple doors shall be lockable and provide adequate access to interior of enclosure. Access aisle ways inside enclosure shall be large enough to provide adequate clearance to interior components and equipment requiring maintenance. Instruments, controls and generator main-line overcurrent protective devices shall be mounted within enclosure.
  - 2. Doors: Hinged aisle and component access doors with exterior padlocking provisions. Personnel doors shall be equipped with panic hardware. Provide steps and railings as required to access each entry door.
  - 3. Structural Design and Anchorage: Comply with ASCE 7.
    - a. Minimum wind loading: 125 miles-per-hour unless ASCE 7 requires greater.
  - 4. Space Heater: Thermostatically controlled and sized to prevent condensation.
  - 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. Sound attenuation: Sound level measured at a distance of 23 feet from center of generator enclosure shall be 65dBA or less at full-load operation of generator. Sound level is defined as the level of sound generated by the generator, and all associated components and equipment, packaged within the enclosure; including engine exhaust and cooling-air intake and discharge.
  - 8. Muffler Location: Within enclosure.
- B. 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.
- C. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Fed from generator power panel.
  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.
- D. Generator Power Panel: Factory-wired, load-center type, 208Y/120-volt power panelboard, sized as recommended by manufacturer to accommodate loads associated with generator such as jacket water heater, enclosure space heater, dampers, louvers, lights, and receptacles. Loads described shall be factory wired to generator power panel. Generator power panel shall be fed from external 480-volt 3-phase feed; provide step-down transformer with primary disconnect switch in generator enclosure.

## **2.8 POWER MONITOR**

- A. Power Monitor: Each generator shall be equipped with a UL-listed microprocessor-based power monitor with local display, flush-mounted in generator instrument panel. Power monitoring data shall include real-time rms values for the following:
  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. Apparent Power: Per phase and three-phase total.
  6. Power Factor: Per phase and three-phase total.
  7. Displacement Power Factor: Per phase and three-phase total.
  8. Frequency.
  9. THD: Current and voltage.
  10. Accumulated Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute.)

## **2.9 BAS INTERFACE**

- A. Interconnection to Building Automation System: Each generator controller, power monitor and circuit breaker trip unit shall be fully-integrated with the building automation system (BAS) via a communications network connection. Coordinate required interface protocol with BAS supplier and provide BAS supplier with a comprehensive points list to facilitate system programming. Refer to HVAC controls diagrams and sequences for additional information. In addition to required generator monitoring points indicated on HVAC controls diagrams and sequence, BAS shall monitor the following:
  1. Total generator running kW
  2. Generator alarm.
  3. Generator circuit breaker status: open, closed, tripped, ground fault.
  4. Each monitoring point specified.
  5. Each alarm and status indication specified.

## **2.10 VIBRATION ISOLATION DEVICES**

- A. Elastomeric Isolator Pads: Oil- and water-resistant elastomer or natural rubber, arranged in single or multiple layers, molded with a nonslip pattern and galvanized-steel baseplates of sufficient stiffness for uniform loading over pad area, and factory cut to sizes that match requirements of supported equipment.
  1. Material: Bridge-bearing neoprene, complying with AASHTO M 251 separated by steel shims.
  2. Minimum Deflection: 1 inch.

## **2.11 FINISHES**

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

## **2.12 SOURCE QUALITY CONTROL**

- A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or approved equivalent components and equipped with identical or approved 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 2 inches on minimum 6-inch-high concrete base. Secure sets to anchor bolts installed in concrete bases. Refer to site Civil Drawings for additional details on concrete base construction.
- D. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."
- E. 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 23 Section "Hydronic Piping."
- F. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

### **3.3 CONNECTIONS**

- A. Ground equipment according to Division 26 Section "Grounding and Bonding." Provide minimum 5-ohm ground resistance at generator location.
- B. Connect wiring according to Division 26 Section "Low Voltage Conductors and Cables."

### **3.4 IDENTIFICATION**

- A. Identify system components according to Division 23 Section "Identification for HVAC Piping and Equipment" and Division 26 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.
  - 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.
- B. Tests and Inspections:
  - 1. Perform tests recommended by manufacturer, tests indicated below, 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.
    - a. Visual and Mechanical Inspection:
      - 1) Compare equipment nameplate data with Drawings and the Specifications.
      - 2) Inspect physical and mechanical condition.
      - 3) Inspect anchorage, alignment, and grounding.
      - 4) Verify that the unit is clean.
    - b. Electrical and Mechanical Tests:
      - 1) Perform insulation-resistance tests according to IEEE 43.
        - a. Machines Larger than 200 hp: Test duration shall be 10 minutes. Calculate polarization index.
        - b. Machines 200 hp or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.
      - 2) Test protective relay devices.
      - 3) Verify phase rotation, phasing, and synchronized operation as required by the application.
      - 4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.
      - 5) Perform vibration test for each main bearing cap.
      - 6) Conduct performance test according to NFPA 110.
      - 7) Verify correct functioning of the governor and regulator.
  - 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. 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.
  10. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at eight locations within 21 feet of the enclosure, and at the closest property line, and compare measured levels with required values.
- C. Coordinate tests with tests for transfer switches and run them concurrently.
  - D. 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.
  - E. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - H. Remove and replace malfunctioning units and retest as specified above.
  - I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
  - J. 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.
  - K. 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. Refer to Division 1 Section "Demonstration and Training."
- B. Coordinate this training with that for transfer switches.
- C. Demonstrate that equipment under this Section is properly monitored at the front-end of the building automation system.

END OF SECTION

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## **SECTION 26 36 00 - TRANSFER SWITCHES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes automatic transfer switches rated 600 V and less, including the following:
  - 1. Bypass/isolation switches.
  - 2. Remote annunciation and control systems.
  - 3. Power monitoring.
- B. Related Sections include the following:
  - 1. Division 23 Sections relating to "Building Automation System" for network interfaces and protocols, and sequences of operation.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components, profiles and finishes for each type and size of transfer switch.
  - 2. 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.
  - 1. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.
  - 2. Riser Diagram: Show interconnection wiring between transfer switches, bypass/isolation switches, annunciators, and control panels.
  - 3. BAS Interconnection: Show detailed information regarding network interconnections between transfer switch components and building automation system, including coordinated network protocol and necessary communications transmission pathways to be utilized. Clearly document that BAS interconnections have been coordinated.
  - 4. Points List: Provide a comprehensive points list for each component to be interconnected to the BAS. Clearly identify points that will be monitored by the BAS.
- C. Comprehensive Product Data and Shop Drawing Submittal Package: Submit product data and shop drawing information for all items specified under this Section in a single comprehensive Product Data and Shop Drawing Submittal Package. This Submittal Package shall contain only items specified under, or directly related to, this Section. Submittals that do not include each specified unit or contain incomplete submittal information will be rejected.
- D. Qualification Data: For manufacturer and testing agency.
- E. Source quality-control reports.
- F. Field quality-control test reports.

- G. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
  - 1. Features and operating sequences, both automatic and manual.
  - 2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.
- H. Warranty: Special warranty specified in this Section.

#### **1.4 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.
- B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of NETA.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.
- C. Source Limitations: Obtain transfer switches, bypass/isolation switches, and remote annunciators 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. Product Selection for Restricted Space: Drawings indicate maximum dimensions for transfer switches including clearances between switches and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- F. Comply with NEMA ICS 1.
- G. Comply with NFPA 70.
- H. Comply with NFPA 110.
- I. Comply with UL 1008 unless requirements of these Specifications are stricter.

#### **1.5 COORDINATION**

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate interconnections with the BAS and provide required field support to demonstrate that equipment under this Section is properly reporting at the front-end of the building automation system.

#### **1.6 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of transfer switch and transfer switch components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: 5 years from date of Substantial Completion.

#### **1.7 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 exercising to check for proper operation and load transfer. 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.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Emerson; ASCO Power Technologies, LP (7000 Series.)
  - 2. Russelectric, Inc. (RTS-03)

### **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. Short-time withstand capability for three cycles minimum.
- C. Transfer Switch Controller: Programmable microprocessor-based controller with keypad and LCD graphical display for viewing data and setting operational parameters.
  - 1. Display shall include retransfer countdown elapsed timer.
- D. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- F. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources.
- G. 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.
  - 4. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 5. Material: Hard-drawn copper, 98 percent conductivity.
  - 6. Main, Neutral and Ground Lugs: Compression type.
  - 7. Internal copper ground bus.
  - 8. Connectors shall be marked for conductor size and type according to UL 1008.
- H. Neutral Switching: Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.
- I. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.
- J. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Electrical Identification."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.
  2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
  3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- K. Enclosures: General-purpose NEMA 250, Type 1, 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: Open-transition; double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated; load transfer occurs within 100ms.
- C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.
- D. 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.
- E. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- F. Automatic Transfer-Switch Features:
  1. Controller operates through a period of loss of control power.
  2. Under-voltage Sensing for Each Phase of Normal and Alternate 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.
  3. 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.
  4. 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.
  5. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained under-voltage of emergency source, provided normal supply has been restored.
  6. Test Switch: Simulate normal-source failure.
  7. Switch-Position Pilot Lights: Indicate source to which load is connected.
  8. 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."
  9. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

10. 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.
  11. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
  12. Engine Shutdown Contacts: Time delay adjustable from zero to fifteen minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
  13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
    - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    - b. Push-button programming control with digital display of settings.
    - c. Integral battery operation of time switch when normal control power is not available.
- G. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

## 2.4 REMOTE ANNUNCIATOR AND CONTROL SYSTEM

- A. Source Limitations: Same manufacturer as transfer switch in which installed.
- B. Functional Description: Include the following functions for transfer switches:
  1. Indication of sources available, as defined by actual pickup and dropout settings of transfer-switch controls.
  2. Indication of switch position.
  3. Indication of switch in test mode.
  4. Indication of failure of digital communication link.
  5. Key-switch or user-code access to control functions of panel.
  6. Control of switch-test initiation.
  7. Control of switch operation in either direction.
- C. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically shall revert to standalone, self-contained operation. Automatic transfer-switch sensing, controlling, or operating function shall not depend on remote panel for proper operation.
- D. Remote Annunciation and Control Panel: Solid-state components. Include the following features:
  1. Controls and indicating lights grouped together for each transfer switch.
  2. Audible signal with silencing switch.

3. Label each indicating light control group. Indicate transfer switch it controls, location of switch, and load it serves.
4. Digital Communication Capability: Matched to that of transfer switches supervised.
5. Mounting: Flush, modular, steel cabinet unless otherwise indicated.
6. Lamp Test: Push-to-test or lamp-test switch on front panel.

## **2.5 POWER MONITOR**

- A. Power Monitor: Each transfer switch shall be equipped with a microprocessor-based power monitor with local display, flush-mounted in instrument cabinet door at front of transfer switch. Power monitoring data shall include real-time rms values for the following:
  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. Apparent Power: Per phase and three-phase total.
  6. Power Factor: Per phase and three-phase total.
  7. Displacement Power Factor: Per phase and three-phase total.
  8. Frequency.
  9. THD: Current and voltage.
  10. Accumulated Energy: Real kWh, reactive kVARh, apparent kVAh (signed/absolute.)

## **2.6 BAS INTERFACE**

- A. Interconnection to Building Automation System: Each transfer switch shall be monitored by the building automation system (BAS) via a communications network connection. Coordinate required interface protocol with BAS supplier and provide BAS supplier with a comprehensive points list to facilitate system programming. Refer to HVAC controls diagrams and sequences for additional information. In addition to required transfer switch monitoring points indicated on HVAC controls diagrams and sequences, BAS shall monitor the following:
  1. Switch position.
  2. Switch mode.
  3. Source availability; both normal and alternate.
  4. Signal before retransfer to normal source.
  5. Alarm conditions.

## **2.7 SOURCE QUALITY CONTROL**

- A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. 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.
- B. Prepare test and inspection reports.
  1. For each of the tests required by UL 1008, performed on representative devices, for emergency, legally required, and optional standby systems. Include results of test for the following conditions:
    - a. Overvoltage.

- b. Undervoltage.
- c. Loss of supply voltage.
- d. Reduction of supply voltage.
- e. Alternative supply voltage or frequency is at minimum acceptable values.
- f. Temperature rise.
- g. Dielectric voltage-withstand; before and after short-circuit test.
- h. Overload.
- i. Contact opening.
- j. Endurance.
- k. Short circuit.
- l. Short-time current capability.
- m. Receptacle withstand capability.
- n. Insulating base and supports damage.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Floor-Mounting Switch: Provide concrete base and securely anchor switch to base by bolting. Refer to Division 26 Section "Hangers and Supports for Electrical Systems" for concrete base requirements.
- B. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.
- C. Identify components according to Division 26 Section "Electrical Identification."
- D. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
- E. Comply with NECA 1.

#### **3.2 CONNECTIONS**

- A. Wiring to Remote Components: Match type and number of cables and conductors to generator sets, motor controls, control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.
- B. Wiring Method: Install cables in raceways and cable trays except within electrical enclosures. Conceal raceway and cables except in unfinished spaces.
- C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Division 26 Section "Low-Voltage Conductors and Cables."

#### **3.3 FIELD QUALITY CONTROL**

- A. Engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
- C. Tests and Inspections:
  - 1. After installing equipment, perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification (ATS) for automatic transfer switches. Certify compliance with test parameters.

2. Visual and Mechanical Inspection:

- a. Compare equipment nameplate data with Drawings and Specifications.
- b. Inspect physical and mechanical condition.
- c. Inspect anchorage, alignment, grounding, and required clearances.
- d. Verify that the unit is clean.
- e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
- f. Verify that manual transfer warnings are attached and visible.
- g. Verify tightness of all control connections.
- h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
  - 1) Use of low-resistance ohmmeter.
  - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
- i. Perform manual transfer operation.
- j. Verify positive mechanical interlocking between normal and alternate sources.
- k. Perform visual and mechanical inspection of surge arresters.
- l. Inspect control power transformers.
  - 1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
  - 2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
  - 3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.

3. Electrical Tests:

- a. Perform insulation-resistance tests on all control wiring with respect to ground.
- b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
- c. Verify settings and operation of control devices.
- d. Calibrate and set all relays and timers.
- e. Verify phase rotation, phasing, and synchronized operation.
- f. Perform automatic transfer tests.
- g. Verify correct operation and timing of the following functions:
  - 1) Normal source voltage-sensing and frequency-sensing relays.
  - 2) Engine start sequence.
  - 3) Time delay on transfer.
  - 4) Alternative source voltage-sensing and frequency-sensing relays.
  - 5) Automatic transfer operation.
  - 6) Interlocks and limit switch function.



- 7) Time delay and retransfer on normal power restoration.
  - 8) Engine cool-down and shutdown feature.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. 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, perform each electrical test for transfer switches stated in NETA ATS and 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. Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
    - f. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for one pole deviating by more than 50 percent from other poles.
    - g. 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.
- D. Coordinate tests with tests of generator and run them concurrently.
  - E. 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.
  - F. Transfer switches will be considered defective if they do not pass tests and inspections.
  - G. Remove and replace malfunctioning units and retest as specified above. Correct deficiencies identified by tests and observations and retest until specified requirements are met.
  - H. Prepare test and inspection reports.
  - I. 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 01 Section "Demonstration and Training."
- B. Training shall include testing ground-fault protective devices and instructions to determine when the ground-fault system shall be retested. Include instructions on where ground-fault sensors are located and how to avoid negating the ground-fault protection scheme during testing and circuit modifications.
- C. Coordinate this training with that for generator equipment.
- D. Demonstrate that equipment under this Section is properly monitored at the front-end of the building automation system.

END OF SECTION

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## **SECTION 26 41 13 - LIGHTNING PROTECTION**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes lightning protection for buildings and site components.

#### **1.3 DEFINITIONS**

- A. LPI: Lightning Protection Institute.
- B. NRTL: National recognized testing laboratory.

#### **1.4 SUBMITTALS**

- A. Product Data: For air terminals, conductors, connectors 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, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
- 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 an NRTL or LPI.
- 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. Comprehensive Product Data and Shop Drawing Submittal Package: Submit product data and shop drawing information for all items specified under this Section in a single comprehensive Product Data and Shop Drawing Submittal Package. This package shall also include installer qualification data and roof adhesive certification. Submittals that do not include each specified unit or contains incomplete submittal information will be rejected.
- F. Field inspection reports indicating compliance with specified requirements.

#### **1.5 QUALITY ASSURANCE**

- A. Installer Qualifications: Engage an experienced installer who is an NRTL or who is certified by LPI as a Master Installer/Designer.
- B. Listing and Labeling: As defined in NFPA 780, "Definitions" Article.

#### **1.6 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 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. Automatic Lightning Protection.
  - 2. ERICO International Corporation.
  - 3. Harger Lightning Protection, Inc.
  - 4. Heary Bros. Lightning Protection Co. Inc.
  - 5. Independent Protection Co.
  - 6. Thompson Lightning Protection, Inc.

### **2.2 LIGHTNING PROTECTION SYSTEM COMPONENTS**

- A. Comply with UL 96.
- B. Air Terminals:
  - 1. NFPA 780 Class II, copper, solid, unless otherwise indicated.
  - 2. Rounded tip.
  - 3. Single-Membrane, Roof-Mounting Air Terminals: Designed for single-membrane roof materials.
- C. Conductor Splices and Connectors: Compression fittings that are installed with hydraulically-operated tools, or exothermic welds, approved for use with the class type specified.
- D. Ground Rods, Ground Loop Conductors, and Concrete-Encased Electrodes: Comply with Division 26 Section "Grounding and Bonding" and with standards referenced in this Section.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends and narrow loops.
- C. Conceal the following conductors:
  - 1. System conductors.
  - 2. Down conductors.
  - 3. Interior conductors.
  - 4. Conductors within normal view from exterior locations at 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 or hydraulically-compressed connections for all conductor splices and connections between conductors and other components, except do not use exothermic-welded connections above single-ply membrane roofing.
- E. Air Terminals on Single-Ply Membrane Roofing: Comply with adhesive manufacturer's written instructions.

- F. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.
- G. A counterpoise installation based on requirements in Division 26 Section "Grounding and Bonding" may be used as a ground loop required by NFPA 780, provided counterpoise conductor meets or exceeds minimum requirements in NFPA 780.
  - 1. Bond ground terminals to counterpoise conductor.
  - 2. Bond grounded metal bodies on building within 12 feet of ground to counterpoise conductor.
  - 3. Bond grounded metal bodies on building within 12 feet of roof to interconnecting loop at eave level or above.
- H. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

### **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. UL Inspection: Provide inspections as required to obtain a UL Master Label for system.
- B. Provide a UL Master Label for system.

END OF SECTION 26 41 13

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## **SECTION 26 51 00 - INTERIOR LIGHTING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Interior lighting fixtures, lamps, and ballasts, LED engines and drivers.
  - 2. Emergency lighting units.
  - 3. Exit signs.
  - 4. Lighting fixture supports.
- B. Related Sections include the following:
  - 1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multiple lighting relays and contactors.
  - 2. Division 26 Section "Wiring Devices" for manual wall-box dimmers for incandescent lamps.

#### **1.3 DEFINITIONS**

- A. LM: Lumen Maintenance (factor): extrapolated performance projections for the platforms noted in a 25°C ambient, based on 10,000 hours LED testing (tested per IESNA LM-80-08 and projected per IESNA TM-21-11)
- B. CU: Coefficient of Utilization.
- C. cd: candela:
- D. CCT: Correlated color temperature.
- E. CRI: Color-rendering index.
- F. LER: Luminaire efficacy rating.
- G. RCR: Room cavity ratio.
- H. Lumen: Measured output of lamp and luminaire, or both.
- I. Mean lumens: average light output over the lamp's rated life, which reflects the gradual deterioration of performance due to the rigors of continued operation.
- J. Luminaire: Complete lighting fixture, including ballast housing if provided.
- K. SSL: solid state lighting

- L. LED: lighting emitting diodes
- M. SDCM: Standard deviation Color match.

#### **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. Energy-efficiency data.
  - 4. Life, output, and energy-efficiency data for lamps.
  - 5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.
    - a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
    - b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Include plans, elevation, sections, details, features, and accessories.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection
  - 2. Wiring Diagrams: Power and control wiring.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. 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.
    - g. Projectors & cameras
    - h. Treatment or specialty ceiling mounted equipment
  - 5. Perimeter moldings.
- B. Samples for Verification: Interior lighting fixtures designated for sample submission in Interior Lighting Fixture Schedule. Each sample shall include the following:

1. Accessories: Cords and plugs.
  2. Pendant support system.
  3. Installation instructions
- C. Product Certificates: For each type of driver/ballast for bi-level and dimmer-controlled fixtures, signed by product manufacturer.
- D. Qualification Data: For agencies providing photometric data for lighting fixtures.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
- G. Warranties: Special warranties specified in this Section.

## **1.6 QUALITY ASSURANCE**

- A. Each Luminaire different than the one listed in the lighting fixture specification shall be provided with equal or better performance and provide photometric information for its evaluation
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7.
- 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 NFPA 70.
- E. FMG Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FMG.
- F. LED compliance with ANSI/ANSLG (ANSLG: American National Standard Lighting Group)
1. Specifications for the Chromaticity of Solid State Lighting Products, intended to be used Indoors)
  2. Harmonic Emission Limits – Related Power Quality Requirements for Lighting Summarizes harmonic limits and methods of measurements for lighting equipment including SSL drivers and power supplies
- G. 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.



## **1.7 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.

## **1.8 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.
- B. Philips Bodine (or approved equivalent) products shall be fully warranted for one, two, three or five year (refer to each product cutsheet). This warranty covers only properly installed Philips Bodine products used under normal conditions. For the warranty period, Philips Emergency Lighting will, at its option, repair or replace without charge a defective unit, provided it is returned to the factory transportation pre-paid and our inspection determines it to be defective under terms of warranty. Repair or replacement, as stated above, shall constitute the purchaser's exclusive warranty, which does not extend to transportation, installation, labor or any other charges; nor does it apply to any equipment of another manufacturer used in conjunction with the Philips Bodine product.
  - 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: 7 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.
- C. 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: 5 years from date of Substantial Completion.
- D. Warranty Period for Electromagnetic Ballasts: 3 years from date of Substantial Completion.

## **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. Driver: 1 for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. 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. Manufacturers: Subject to compliance with requirements, provide products by one of the 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. Metal Parts: Free of burrs and sharp corners and edges.
- C. Sheet Metal Components: Sheet metal work shall be free of burrs, sharp corners and edges, tool marks and dents, and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true of adequate strength and structural rigidity to prevent any distortion after assembly.
- D. 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.
- E. 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.
- F. Fixtures shall be completely wired at the factory.
- G. Mounting Frames and Rings: If ceiling system requires, each recessed and semi-recessed fixture shall be furnished with a mounting frame or ring compatible with the ceiling in which they are to be installed. The frames and rings shall be one piece or constructed with electrically-welded butt joints, and of sufficient size and strength to sustain the weight of the fixture.
- H. Light leaks:
  1. Between ceiling trims of recessed lighting equipment and the ceilings will not be approved.
  2. Between lighting components within the fixtures (louvers, trims, etc) will not be approved.
- I. Yokes, brackets and supplementary supporting members needed to mount lighting fixtures to carrier channels or other suitable ceiling members shall be furnished and installed by the Contractor.
- J. Adjustable Angle Fixtures: Each lighting fixture which has a beam angle adjustment shall have reliable angle locking devices.
- K. Plastic Diffusers, Covers, and Globes:
  1. Acrylic Lighting Diffusers: Plastic for lenses and diffusers shall be formed of colorless 100% virgin acrylic as manufactured by Rohm & Haas, Dupont or as acceptable. The quality of the raw material must exceed IES, SPI, and NEMA Specifications by at least 100% which, as a minimum standard, shall not exceed a yellowness factor of 3 after 2,000 hours of exposure in the Fade-meter or as tested by an independent test laboratory. Acrylic plastic lenses and diffusers shall be properly cast, molded or extruded as specified, and shall remain free of any dimensional instability, discoloration embrittlement, or loss of light transmittance for at least 15 years

- 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.

### 2.3 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.
  - 3. Master/Remote Sign Configurations:
    - a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in [LED power supply for power connection to remote unit.
    - b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

### 2.4 LED LIGHTING

- A. Color temperature: shall be 3500K.
- B. CRI: LED CRI shall be minimum 82 unless otherwise noted. Manufacturer must provide all "R" values or R1 through R15.
- C. The LED system shall use 14-bit or greater nonlinear scaling techniques for high-resolution output. Manufacturer of LED systems shall utilize an advanced production LED binning process to maintain color consistency.

- D. The LED fixture shall be operated at constant and carefully regulated current levels. LEDs shall not be overdriven beyond their specified nominal voltage and current. Data must be submitted showing and proving the measurement test point of the LED case within the fitting in situ.
- E. Thermal management: all LED fixtures shall be thermally protected. They must be passively cooled through conduction unless otherwise noted
- F. LED fixture housing shall be designed to transfer heat from the LED board to the outside environment.
- G. LED fixture manufacturer must provide fixture wattage information and not LED data.
- H. For wet and damp use, LED-based fixture itself shall be sealed, rated, and tested for appropriate environmental conditions, not accomplished by using an additional housing or enclosure.
- I. LED fixture shall be UL listed or UL classified, CE certified. And PSA marked. LED fixture and systems shall meet RoHS (Removal of Hazardous Substances) directives. Manufacturer shall be able to provide supporting documentation of the product meeting third party regulatory compliance as well as environmental testing results.
- J. Manufacturer shall provide optical performance, polar diagrams, and relevant luminance and illuminance photometric data based on test results from an independent testing lab
- K. Rated Life: LED Fixtures shall be rated for 59,000 hour minimum performance on all LED diode components.
- L. Warranty: LED Manufacturers shall provide a minimum 5 year warranty on LED components. Along with it, manufacturer shall provide warranty and comply with the criteria for: color shifting, lumen and color maintenance described below on bullet points 1 and 2.
- M. If extreme color shift or extreme color inconsistency develops within the warranty period, it will be considered a failure and the Manufacturer shall be responsible for replacing all affected fixtures free of charge.
  - 1. Color Shifting: Color must maintained within (+/- 150 Kelvin) and +/- .003 Duv in accordance with LM-80 Test Procedure and color maintenance data to be provided with submittal in a graphical format to show exact spatial movement of each test sample.
  - 2. Lumen and Color Maintenance Criteria of white LEDs
    - a. Lumen Maintenance: The luminous flux of the Source shall not depreciate more than 20% after 50,000 hours of use as extrapolated from LM-80 test data using the TM-21 calculation.
    - b. Reliability Data Submission for color and lumen maintenance: TM-21 extrapolation curve must be provided prior to fixture submission.
- N. ANSI Standards: LED fixtures shall meet ANSI Standards C78.377-2008, Specifications for the Chromaticity of Solid State Lighting Products, and C82.37-2011, Harmonic Emission Limits – Related Power Quality Requirements for Lighting.
- O. IES LM-79 and LM-80: LED Fixtures shall be LM-79-08, Electrical and Photometric Testing of Solid-State Lighting Devices, and LM-80-08, Measuring Lumen Depreciation of LED Light Sources, tested and approved.
- P. NEMA: LED Diodes and Electronic Drivers shall comply with NEMA guideline SSL-3-2010, High-Power White LED Binning for General Illumination, and SSL-1-2010, Electronic Drivers for LED Devices, Arrays, or Systems.

## 2.5 LED DRIVERS: GENERAL REQUIREMENTS

- A. Hardwired connections to LED fixtures shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
- B. Driver shall operate at 120 volts and 277 volts with +/- 10% variation tolerance.
- C. LED Driver shall operate LED Line modules.
- D. LED Drivers should have Class 2 output.
- E. LED Driver shall have wide operating window to accommodate variation in Led count and forward voltage variation over life and operating conditions.
- F. LED Driver shall have adjustable output current to optimize lumens and efficacy of luminaires.
- G. When using PMS - Pulse with Modulated Signal (applied to the CTRL pin than can change the LED current) to adjust the brightness of white LED, fixture sample shall be tested at the site prior submission of the PO in order to be tested for electromagnetic and radio interference.
- H. LED Driver should have functionality to protect LED module by monitoring module temperature.
- I. LED Driver shall have connectors suitable for field wiring.
- J. LED Driver shall have maximum case temperature of 75C°.
- K. The enclosure case of the driver must be connected to earth ground when installed in the end-use application.
- L. All LED fixtures and power/data supplies shall be provided by a single manufacturer to ensure compatibility. Manufacturer shall have at least eight years of experience designing, selling and supporting intelligent LED systems.
- M. Total Harmonic distortion (THD): Less than 20% at maximum load under all input voltage.
- N. Power Factor shall be greater than 0.9.
- O. Driver shall tolerate sustained open circuit and short circuit output conditions without damage.
- P. Drivers shall meet all the Regulatory requirements:
  - 1. Driver shall not contain any Polychlorinated Biphenyl (PCB).
  - 2. Driver shall be Underwriters Laboratories (UL) recognized for Dry and Damp location and Canadian Standards Association (CSA) certified where applicable.
  - 3. Driver shall be compliant to UL 1310, First Edition, revised dated November 1, 2011.
  - 4. Driver shall comply with ANSI C62.41 Category A for Transient protection.
  - 5. Driver shall comply with ANSI C82.11 where applicable.
  - 6. Driver shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, part 15 (Radio Frequency Devices) and 18 9dor industrial, scientific and medical equipment)
  - 7. Driver shall comply with NEMA 410 for in-rush current limits.
  - 8. Driver shall meet the RoHS Directive 2002/95EC on the restriction of hazardous substances such as lead, cadmium, mercury, hexavalent chromium, PBBs and PBDEs
  - 9. Driver shall be manufactured in a factory certified to ISO 9001 Quality System Standards.
- Q. Driver replacement parts must be aproved by the lighting fixture manufacturer prior installation.

## 2.6 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel 12 gage
- E. Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. 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 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 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.
- D. Suspended Lighting Fixture Support:
  - 1. Pendants and Rods: Where longer than 48 inches, 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.
  - 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
  - 5. Continuous Rows longer than 60", where fixture is one piece or an assembly of multiple sections to complete row lengths as defined in specifications:
    - a. Fixtures should be hung straight and true with no waivers or sag initially or over time.

- b. All suspension points for that fixture shall be perfectly aligned to avoid visible bending and misalignment along the continuous row.
  - c. Provide alignment splines at housing joints to assure tight hairline joints and perfect alignments between housings
- E. Adjust aimable lighting fixtures to provide required light intensities.
- F. Occupancy Adjustments: When requested within 3 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
  - 1. All adjustable lighting units shall be aimed, focused, locked, etc., by the Subcontractor under the supervision of the Lighting Consultant. The Lighting Consultant shall indicate the number of crews (foreman and apprentice) required. All aiming and adjusting shall be carried out after the entire installation is complete. All ladders, scaffolds, etc. required shall be furnished by the Contractor at the direction of the Lighting Consultant. As aiming and adjusting is completed, locking set-screws and bolts and nuts shall be tightened securely.
  - 2. Adjust aimable luminaires in the presence of Architect or and/or end user shall provide written instruction for aiming intent for all the adjustable fixture
- G. Connect wiring according to Division 26.

### **3.2 FIELD QUALITY CONTROL**

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to emergency generator and retransfer to normal.
- B. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.
- C. 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 26 51 00

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## **SECTION 26 56 29 - SITE LIGHTING**

### **PART 1 - GENERAL**

#### **1.1 SCOPE OF WORK**

- A. Exterior luminaries and accessories, underground conduit, wiring, and termination.
- B. Poles and foundations.
- C. Component installation and system testing.
- D. Removal of existing overhead wires, light fixtures, and light poles as shown on the Drawings.

#### **1.2 RELATED SECTIONS AND DOCUMENTS**

- A. Construction Documents

#### **1.3 REFERENCES**

- A. ANSI C78.379 - Electrical Lamps - Incandescent and High-Intensity Discharge Reflector Lamps - Classification of Beam Patterns
- B. ANSI/NFPA 70 - National Electrical Codes
- C. ANSI/IES RP-8 - Recommended Practice for Roadway Lighting
- D. ANSI/IES RP-20 - Lighting for Parking Facilities
- E. IES Lighting Handbook - Current Edition
- F. NEMA – Best practices for metal halide lighting systems
- G. IES DG-5-94 – Recommended lighting for walkways and class I bikeways
- H. NECA/IESNA 501-2000 – Recommended practice for installing exterior lighting systems
- I. IESNA G-1-02 – Guideline for security lighting for people, property and public spaces
- J. IESNA RP-06-01 – Recommended practice for sports and recreational area lighting
- K. AASHTO – Standard specifications for structural supports for highway signs, luminaries and traffic signals, 4<sup>th</sup> edition (2003 interim)
- L. IESNA LM-79 - Electrical and Photometric Measurements of Solid-State Lighting Products
- M. IESNA LM-80 - Approved Method for Measuring Lumen Maintenance of LED Light Sources



#### **1.4 QUALITY ASSURANCE**

- A. Contractor to verify that all specified site lighting satisfies all applicable guidelines and regulations of the utility provider.
- B. Once shop drawings are approved, all lighting is to be ordered in a timely manner. The Contractor is then to inform the Landscape Architect/Engineer immediately, in writing, the date when equipment orders are completed and delivery scheduled.
- C. The Owner reserve the right to request standard production model fixture samples for inspection and to order such tests as the Owner deems necessary to insure compliance with these specifications and to reject those luminaires failing such tests, or those luminaries with improper or inadequate light distributions. The Owner shall be the sole judge as to acceptability.

#### **1.5 SUBMITTALS**

- A. Contractor shall submit 3 color samples for all new light fixtures and poles to the Landscape Architect for approval.
- B. When required by the Owner, each submittal transmitted for approval shall contain:
  - 1. Computer prepared photometric layout of the proposed lighted area, which indicates by isofootcandle readings the system performance.
  - 2. A photometric report from a national independent testing laboratory with report number, date, fixture catalog number, luminaire and lamp specifications; IES calculations, candlepower tabulations, zone lumen summary and isolux plot.
  - 3. The Underwriters Laboratory listing and file number for the specific fixture(s) to be utilized.
  - 4. Pole manufacturer AASHTO calculations indicating the pole and anchor bolts being submitted are capable of supporting the pole and fixture systems being utilized in accordance with specifications.
  - 5. Catalog cuts proving complete conformance to the specifications.

#### **1.6 SYSTEMS PERFORMANCE**

- A. All luminaries as indicated on the drawings shall be "cut-off luminaries". A "cut-off luminaire" is defined by the following limitations of light distributions:
  - 1. At any lateral angle around the luminaire, the candle power per 1000 lumens shall not exceed 25 lumens at an angle of 90 degrees above horizontal and 100 lumens at a vertical angle 80 degrees above horizontal.
- B. All site lighting shall minimize light trespass and spillover onto adjacent properties.

#### **1.7 WARRANTY**

Provide Owner with one year warranty certificate signed by Contractor and by the company providing actual warranty labor. This certificate must be received by the Owner prior to final payment.

## **PART 2 - PRODUCTS**

### **2.1 DRIVERS FOR LED LAMPS**

#### **A. General Requirements**

1. LED Engines / Drivers: Comply with UL 1993, UL 8760.
2. Designed for type and quantity of lamps served.
3. Designed for the full rated light output unless dimmable controls are indicated.

B. Power Factor: 0.95 or higher unless otherwise indicated.

C. Total Harmonic Distortion: Less than 20 percent.

D. Transient Voltage Protection: IEEE C62.42.1. and IEEE C62.42.2, Category A or better.

E. Interference: Comply with 47 CFR 18, Ch. 1, Subpart b, for regulations concerning the emission of electronic noise.

### **2.2 LED LAMPS**

#### **A. General Requirements**

1. Integral LED lamps: Comply with UL 1993, UL 8750.
2. LED packages and LED arrays: Comply with UL 8750.
3. Color temperature as indicated on the drawings.

B. LEDs shall utilize appropriate technology to achieve the indicated color.

C. Average rated life shall be a minimum 90,000 hours unless otherwise indicated.

D. LEDs shall be wired so that a failure of one LED will not adversely affect output of the lamp.

E. Circuitry shall prevent perceptible flicker over the operating voltage range even if in dimmable mode.

F. LED's shall meet the LM-80 testing criteria as set forth by the Federal Department of Energy

### **2.3 LED LUMINAIRES, POLES, SUPPORT ARMS, AND BRACKETS**

Refer to site lighting plan and schedule on contract documents for luminaire locations, additional specifications, accessories, and specific model numbers.

### **2.4 PRE-CAST CONCRETE FOUNDATIONS**

A. Pre-cast concrete light pole foundations shall be reinforced per the Contract Documents.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

A. Provide concrete base for light poles at location indicated on the construction documents.

B. Install poles plumb. Provide shims or double nuts where necessary to adjust plumb. Grout around each base.

- C. Install lamps in each luminaire. Contractor shall exercise caution when handling lamps. Contractor shall avoid handling lamps without clean gloves or a protective cloth wrap.
- D. Bond luminaries, metal accessories and metal poles to branch circuit equipment grounding conductor. Provide supplementary grounding electrode at each pole.

### **3.2 FIELD QUALITY CONTROL**

- A. Operate each luminaire after installation and connection. Inspect for improper connections and operation.
- B. Measure illumination levels to verify conformance with performance requirements as specified on the construction drawings and/or local ordinances.
- C. Take measurements during the night sky, without moon or with heavy overcast clouds effectively obscuring the moon.
- D. Aim and adjust luminaire to provide illumination levels and distribution as indicated on the construction drawings or as directed.

### **3.3 CLEANING**

- A. Clean electrical parts to remove conductive and deleterious materials.
- B. Remove dirt and debris from enclosure.
- C. Clean photometric control surfaces as recommended by manufacturer.
- D. Clean finishes and touch up damage.

### **3.4 PROTECTION OF FINISHED WORK**

- A. Contractor shall protect all work while construction is in progress. Contractor is responsible for any damage incurred during construction.
- B. Relamp luminaries which have failed or been damaged during construction at substantial completion.

### **3.5 TESTING**

Perform and record voltmeter measurements according to standard testing procedures. In addition, provide labor, material, and energy to conduct a parking lot light test at least 30 days prior to Substantial Completion date. This test shall consist of continuous operation of fixtures and lamps for a time period of 100 hours. Contractor shall witness and certify the continuous operation and time duration of the test. At the end of the testing period, immediately request warranty parts and replace defective components at least three days prior to Substantial Completion date.

### **END OF SECTION 26 56 29**

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## SECTION 27 10 00 - STRUCTURED CABLING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Description: This section includes, but is not limited to, the following:
  - 1. A complete and operational plenum rated structured cabling system consisting of Category 6A station cabling, fiber optic and copper backbone cabling, associated termination hardware, racks, and accessories. This structured cabling system is to support voice, data, wireless, security, AV, BMS, and other network connectivity requirements throughout the project.
  - 2. The Standard for structured cabling system connectivity is Panduit.
  - 3. Backbone cabling system consisting of plenum rated, Category 6A cables, single mode OS-2 cable, terminations, patch panels, enclosures, and accessories.
  - 4. Service provider extensions from the building entrance to the MDF, including data and voice connectivity, video and CATV connectivity and other provider/connectivity circuits. Cabling is to be plenum rated and consistent with the media type, configuration, and quantity provided by the service providers.
  - 5. Public address system consisting of cabling, speakers, sources, connection to fire alarm system, zoning, external access, and accessories to ensure a complete and operational system. Configure, and integrate into the owner's cisco unified communication system. Coordinate addressing and integration with the owner IT contacts and complete the installation, configuration, and testing to their satisfaction. Provide an interface for the fire alarm system override connection from the fire alarm system. The override is to interrupt announcements during emergency conditions.
  - 6. Emergency Communication System:
    - a. Elevator in-car emergency communication system: this system consists of Category 6A station cables, two per elevator control room, with sufficient slack to be routed to the elevator control interfaces for connection to the communication conductors in the elevator traveler cable system, by the elevator installer. The communication conductors and elevator communication device are by the elevator contractor. Provide cable connectivity to the MDF directly or through copper backbone cabling, for cross connect to the communication utility service connection. This section is to provide cross connection to the communications carrier termination of the elevator communication emergency lines.
  - 7. UPS and battery systems in each of the four IDF rooms.
  - 8. Provide materials in quantities sufficient for complete installations as indicated in drawings and in this specification, whether or not all such components are contained in the drawings and specifications.
- B. Section Includes:
  - 1. Pathways.
  - 2. UTP cable

3. UTP cable hardware.
4. Optical fiber cable
5. Optical fiber cable hardware.
6. Coaxial cable
7. Coaxial cable hardware.
8. Equipment racks, cabinets and accessories.
9. Grounding.
10. Labeling.
11. Accessories.

### 1.3 STANDARDS

- A. ANSI/TIA-568-C.0: Generic Telecommunications Cabling for Customer Premises.
- B. ANSI/TIA-568-C.1: Commercial Building Telecommunications Cabling Standard
- C. ANSI/TIA-568-C.2: Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
- D. ANSI/TIA-568-C.3: Optical Fiber Cabling Components Standard.
- E. ANSI/TIA/EIA-569-B: Commercial Building Standard for Telecommunications Pathways and Spaces.
- F. ANSI/TIA/EIA-606-A: Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
- G. ANSI/J-STD-607-A: Commercial Building Grounding and Bonding Requirements for Telecommunications.
- H. ANSI/TIA-1152, Requirements for Field Test Instruments and Measurements for Balance Twisted-Pair Cabling.
- I. TIA-492AAAC, Detail Specification for 850 nm Laser Optimized, 50-Micron Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers
- J. American Society for Testing and Materials, (ASTM)
- K. Building Industry Consulting Services International (BICSI)
- L. Federal Communications Commission (FCC)
- M. FCC Part 15 and Part 68
- N. Insulated Cable Engineers Association (ICEA)
- O. Institute of Electrical and Electronic Engineers, (IEEE)
- P. National Electrical Code (NEC)
- Q. National Fire Protection Association (NFPA)
- R. Underwrites Lab (UL)
- S. Governing Building Codes

## 1.4 DEFINITIONS

- A. As used in all Sections, "provide" means "furnish and install." "Furnish" means "to purchase and deliver to the project site complete with every necessary appurtenance and support," and "Install" means "to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project.
- B. Insofar as submittals, reviews, and approvals are concerned, the words "Architect" and "Engineer" may be used interchangeably in this division.
- C. Electronic Copy means copy in a searchable PDF format and excludes scanned material and faxed material. Scanned material and faxed material shall not be submitted.

## 1.5 SUBMITTALS

- A. Complete Submittals: Provide a complete submittal package except for the close out submittal requirements. Incomplete submittals will be rejected and returned for completion and resubmission.
- B. Product Data:
  - 1. Provide a summary spreadsheet showing each item and associated information identified below:
    - a. Specification item paragraph number
    - b. Item name
    - c. Manufacturer description
    - d. Manufacturer part number
    - e. Quantity required for the project
    - f. Accessories and/or related items
    - g. "As specified" yes/no
    - h. If not as specified, provide "or equal" data to completely describe the proposed substitutes
    - i. Page number in submittal package where item product information starts (Provide spreadsheet entries and submittal product information in the same order as the items appear in the specification. For equipment and/or items not individually identified in the specification, include these items at the end.)
  - 2. For each item, provide detailed manufacturer data sheets clearly marked, with colored arrows, to identify the specific item and configuration being submitted. Organize this information in the order identified in item "Product Data" above. Submittals that are not provided with the above information, and in the specified format, will be rejected.
  - 3. Provide color selections for items that require color decisions. Provide physical material submissions of the items in the available colors, three copies or samples of each color selection set of options.
  - 4. Submit documentation regarding the manufacturer's 20 year or greater extended warranty. The documentation is to include a sample of the warranty that will be provided to the customer when the installation is complete and documentation of the support procedure for warranty issues. Provide an application assurance manual documenting the vendor supported applications and application guidelines. In addition, furnish manufacturer's documentation stating the contractor is certified to perform warranty work.
- C. Shop Drawings: Provide one-line diagrams showing the devices, connections, cabling, routing, and related information. Identify each device, opening, pathway, conduit, tray, and/or system. Provide rack elevations for each IDF room and show the location and cabling of the UPS unit and batteries.
- D. Samples: For workstation outlets, jacks, jack assemblies, and faceplates. For each exposed product and for each color and texture specified, provide two samples. Provide a complete color chart of available colors and finishes for each item.
- E. Contractor Qualifications:

1. Provide reference information including, project name and description, contact name, email and telephone number, and project location for five projects of similar system, size and scope completed within the past two years.
2. Provide a technical resume for the Project Manager and on-site installation Supervisor assigned to this project. Include copies of certifications and evidence of training from manufacturers, industry organizations and field related training.
3. Identify subcontractors to be used on this project. The subcontractor(s) are required to possess the same credentials as documented above. The subcontractor's documentation must be included in the contractor documentation. The contractor will furnish the manufacturer's certification statement individually for both the contractor and subcontractor.
4. Provide evidence that the contractor is authorized by the manufacturer to furnish warranty services, components, and systems.

F. Closeout Submittals, due upon substantial completion of the project:

1. Operation and Maintenance Data: Provide operation, and maintenance manuals for each item/system.
2. As-built drawings, AutoCAD format, and PDF, which show the actual construction conditions and configurations. Make all modifications to these drawings by removing all superseded data and show the completed "As-Built" installation. The "As-Built" must be made available in the form of reproducible prints and an AutoCAD drawing file format for input to other systems. Maintain the as-built drawings throughout the project, and provide two hard copies, and electronic copies of the final conditions as-built drawings.
3. Deliver the completed Record Drawings, identified above, properly titled and dated to the Owner labeled "As-Built" drawings. These drawings are to be completed and delivered two (2) weeks prior to the cutover and become the property of the Owner.
4. Electronic copies of complete Owner and operating manuals and user guide for each system and record drawings. Instructions must include part numbers and names, addresses, and telephone numbers of parts source. After approval, provide electronic copies of the owner's and operating manuals and one hard copy of each, to the Owner.
5. Test reports, as specified, on CDs using excel or other similar software. If the software used to document test results is proprietary, then the contractor will include the necessary software and licenses to read and store the test results.
6. Provide the completed documentation for the warranty for all parts, components, labor, testing, and materials against defects, faulty workmanship, and/or failure for one full year following system(s) acceptance. Provide an additional Manufacturer's 20 year or longer extended warranty for materials, labor and application performance to the system industry specifications in place at the time of this award. The extended warranty is to be issued and backed by the Manufacturer of the structured cabling system. The warranty period is to be a minimum of 20 years from the date of Owner acceptance.

G. Submittals

The following is a summary table of the required submittals. It is provided as a reference and is not a complete list of the required submittals but provides guidance. Additional submittals may be required for the project. Refer to project documents for additional requirements. Submittals that require modification, replacement, additional information, and other changes are in addition to the submittals below and are required as appropriate and/or required.

<b>Submittal</b>
Product Summary Spreadsheet
Product Data Sheets
Shop Drawings
Device Samples
Contractor Qualifications
O&M Manuals and Data, (electronic and hard copy)
As-built Drawings
Cable Test Results
Warranty Documentation

## **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Schedule, arrange, and coordinate with involved parties/trades for shipments, arrivals, loading dock, elevators (as applicable), acceptance, storage, and security of equipment and materials. Assure that these activities do not interfere with other trades or the progress of the project.
- B. Store and protect materials according to manufacturer's specifications and recommended practices.

## **PART 2 - PRODUCTS**

### **2.1 PATHWAYS**

- A. General Requirements: Comply with ANSI/TIA/EIA-569-B.
- B. Cable Support: Cable supports shall be sized to allow a fill ratio that meets the standards specified herein and identified to support the Category of cabling being installed, designed to prevent degradation of cable performance and pinch points that could damage cable. Where not in conduit, EMT, or tray, provide J-hooks at a maximum of four-foot intervals to support the cables.
- C. Cable Trays:
  - 1. Manufacturers: Chatsworth, Cooper-B-Line or Middle Atlantic or approved equivalent.
  - 2. Cable Tray Material: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing.
    - a. Basket Cable Tray Dimensions: 12 inches wide and 4 inches deep.
    - b. Provide mounts, supports, brackets, anchors, suspension materials, and accessories to ensure a complete and operational system.
- D. Conduit and boxes: comply with the requirements of other sections, relating to "raceway and boxes for electrical systems." Comply with these sections. Flexible metal conduit is not acceptable and shall not be used.

### **2.2 BACKBOARDS**

- A. Backboards: Plywood, fire-retardant treated 3/4" by 48" by 96". Comply with requirements for plywood backing panels specified in "Rough Carpentry"

### **2.3 UTP CABLE**

- A. Manufacturers of station, patch, and copper backbone cable: General Cable, CommScope, Belden, Berk-Tek or approved equivalent.
- B. Provide the following colors:
  - 1. Data, blue.
  - 2. Voice only locations, white.
  - 3. Wireless access point locations, green.
- C. Patch and Work Area Cords Description: Factory-made, four-pair cables in various colors and lengths; terminated with 8-position 8-contact modular plug at each end; colors to match station cable.



1. Patch cords shall have bend-relief-compliant boots. Provide one Patch Cord per cable terminated on patch panel in the following lengths:
  - a. Length:
    - 1) 50 percent 10 foot.
    - 2) 40 percent 7 foot.
    - 3) 10 percent 4 foot.
2. Work Area cords shall have bend-relief-compliant anti-snag boots and color-coded icons. Provide one Work Area Cord per telecommunications outlet connector terminated in the following lengths; colors to match station cabling:
  - a. Length:
    - 1) 40 percent 10 foot.
    - 2) 40 percent 7 foot.
    - 3) 20 percent 4 foot.
3. Meet with the designated representative of the Owner prior to ordering patch and work area cords. Confirm the actual required cord lengths and colors. Do not order cords without designated representative of the Owner approval. Provide the patch cords to the designated representative of the Owner. Provide the labor for patching and labeling the cords in the closet for switch and equipment connections and cord connection and the work area between the outlets and Owner provided devices, or other devices.

## **2.4 UTP CABLE HARDWARE**

- A. Manufacturers: Panduit, CommScope, or University approved equivalent.
- B. Connecting Blocks: 110-style IDC. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
- C. 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. Provide patch panel configurations as indicated, flat, angled, port count, etc.
  1. Patch panels are to be Panduit NKPP48HD High Density Flush 48-Port Modular
  2. Number of Jacks per Field: One for each four-pair UTP cable indicated, plus 25 percent spare per system.
  3. Provide separate patch panels in each closet for the wireless access point cables.
- D. Horizontal cable management: provide horizontal cable management as indicated.
- E. Telecommunications Outlet Connectors: 100-ohm, Modular, color-coded, 8-position 8-contact, twisted-pair connector.
  1. Color: Match cable color.
  2. Icon: Indicate service provided.
- F. Workstation Faceplate: Multi-port-connector assemblies mounted in single gang faceplate.
  1. Plastic Faceplate: High-impact plastic.
  2. For use with snap-in jacks.
    - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
  3. Legend: Machine printed, in the field, using adhesive-tape label.

## **2.5 OPTICAL FIBER CABLE**

- A. Manufacturers: CommScope, Corning, OCC or approved equivalent.
- B. Backbone Cabling Description:
  1. 48 strand Singlemode plenum rated, OS2 8.3/125
  2. Provide in strand counts indicated.

- C. Patch Cords Description: Factory-made, dual-fiber cables; Type LC-to-LC connector.
  - 1. Provide four Patch Cords per telecommunications room, IDF, MDF, or similar room, where fiber will be terminated in the following colors and lengths:
    - a. Length: 10 feet or as directed by the designated representative of the Owner
    - b. Color: to correspond with the fiber type.

## **2.6 OPTICAL FIBER CABLE HARDWARE**

- A. Manufacturers: to be the same as fiber optic cable.
- B. Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors, in a rack mount enclosure. Type LC Connector throughout.

## **2.7 EQUIPMENT RACKS AND CABINETS**

- A. Manufacturers: open racks in MDF or IDFs, by the following, CommScope, Middle Atlantic, Hubbell, Levinton, Cooper B-Line, Chatsworth, or approved equivalent.
- B. Active Equipment Racks: 4-post, 19 inches wide, 7 feet high with 45 rack units. Adjustable mounting rails to 32 inches deep.
  - 1. Shelf: One vented shelf for each active equipment rack.
- C. Passive Equipment Racks: 2-post, 19" wide, 7 feet high with 45 rack units.
- D. Wall Mount Racks: Steel, 19 inches wide, 38 inches high, 25 inches deep with 19 rack units. Swing open to left or right. Rated for 150 pounds.
- E. Vertical Cable Managers: 6 inch vertical cable managers with front and rear channels, with covers.
- F. Horizontal Cable Managers: 2 rack unit horizontal cable managers, or as indicated.
- G. Power Distribution Units, zero rack unit, vertical configuration, APC or equal by Commscope, Leviton or approved equivalent.
  - 1. APC AP 8832, 120V, for each L5-30R
  - 2. APC AP 8841, 208V, for each L6-30R
  - 3. APC AP 8870, 120/208V, for each L14-30P

## **2.8 USP and Battery Systems**

- A. Provide one USP and associated batteries for each of the four IDF rooms. The systems are to be as specified. If substitutions are made, submit a feature by feature comparison with the specified system to ensure compliance.
- B. UPS and batteries are to be APC Smart-UPS SRT 5000VA RM 208V with (2) APC Smart-UPS SRT 192V 5kVA and 6kVA RM Battery Packs model SRT192RMBP, or approved equivalent.

## **2.9 Public Address System**

- A. Provide Algo 8188 SIP IP ceiling speakers or approved equivalent.

## **2.10 GROUNDING**

- A. Comply with requirements in Section 26 05 26 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with ANSI/J-STD-607-A.

## **2.11 IDENTIFICATION PRODUCTS**

- A. Comply with ANSI/TIA/EIA-606-A for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

## **PART 3 - EXECUTION**

### **3.1 WIRING METHODS**

- A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used unless otherwise noted. Conceal pathways and cables unless otherwise noted.
- B. Coordinate telecommunications outlet/connector locations with Architectural drawings and associated electrical outlets. Provide the necessary hardware, accessories, and miscellaneous parts for a complete installation.

### **3.2 INSTALLATION OF CABLES**

- A. Four pair UTP cabling wiring scheme, 568B.
- B. General Requirements for Cabling:
  - 1. Comply with ANSI/TIA-568-C.1.
  - 2. Comply with NECA 1.
  - 3. Comply with BICSI ITSIM, Cable Termination Practices.
  - 4. Install 110-style IDC termination hardware unless otherwise indicated.
  - 5. Terminate conductors; no cable shall contain un-terminated elements unless otherwise noted. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
  - 6. Cables may not be spliced. Secure and support cables at intervals not exceeding 4 feet. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
  - 7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, install lacing bars and distribution spools.
  - 8. Install conductors parallel with or at right angles to sides and back of enclosure.
  - 9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  - 10. Cold-Weather Installation: Bring cable to manufacturer recommended temperature before installing. Heat lamps shall not be used for heating.
  - 11. Route cables, in bundles of no more than fifty. Bundle cables using Hook and Loop wire management straps, tie wraps are not acceptable.
  - 12. In the communications equipment room, install a 10 foot long cable service loop.
  - 13. In the ceiling above the work area outlet, install a 5 foot long cable service loop, secured on a J-hook that is suspended from the building structure, or mounted to sheet rock or a stud above the entry to the raceway to the outlet box.

- 14. Comply with manufacturer and industry pulling tension limits.
- C. Group connecting hardware for cables into separate logical fields.

### **3.3 FIRESTOPPING**

- A. Comply with requirements in Division 076.
- B. Comply with ANSI/TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.
- D. Provide firestopping as indicated, and ensure compliance with codes, regulations, and requirements of other sections, and the AHJ;

### **3.4 GROUNDING**

- A. Install grounding according to BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. Comply with ANSI/J-STD-607-A.

### **3.5 UPS**

- A. Deliver, install, connect, and test per manufacturer's recommended practices.
- B. Provide the UPS and batteries per specification. Install in the IDF rack as approved per the submittals. Connect to power source, connect the battery pack to the UPS unit, and ensure compliance with manufacturer installation requirements and practices.

### **3.6 IDENTIFICATION**

- A. Label system components, wiring, cabling termination hardware, jacks, faceplates, complying with ANSI/TIA/EIA-606-A.
  - 1. Administration Class: 2.
  - 2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
- B. Comply with requirements in Section 09 91 23 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- C. Cable Schedule: Post in prominent location in communications each equipment room. 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.
- D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, hardware, horizontal cables, work areas, grounding buses and pathways, and equipment grounding conductors. Follow convention of ANSI/TIA/EIA-606-A or as indicated or directed in writing by the designated representative of the Owner. Furnish electronic record of all drawings, in software and format selected by Owner.
- E. Cable Identification:

1. Label each horizontal and backbone cable within 4 inches of each termination, where it is accessible in a rack, cabinet, junction box or outlet box.
  2. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Prior to labeling, coordinate with owner for labeling scheme. Label each connector, faceplate, 110-block or other connecting hardware.
- F. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in ANSI/TIA/EIA-606-A.
1. Cables use flexible vinyl or polyester labels that flex as cables are bent.

### **3.7 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
1. Visually inspect cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments and inspect cabling connections for compliance with standards.
  2. Visually confirm correct marking of outlets, cover plates, outlet/connectors, and patch panels.
  3. Visually inspect cable placement, cable termination, grounding and bonding, equipment, patch cords and work area cords, and labeling of all components.
  4. Test instruments shall meet or exceed applicable requirements in standards specified herein.
  5. Horizontal UTP Performance Tests: Test for Category 6A compliance, according to ANSI/TIA-568-C-2.
  6. Backbone UTP Performance Tests: Test each pair for continuity, length and pair polarity.
  7. Optical Fiber Cable Performance Tests: Test at both wavelengths from each end.
  8. Coaxial Cable Tests: Test coaxial cables using a TDR for any faults.
- B. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

### **3.8 CLEANING**

- A. Clean equipment any work areas prior to presentation for acceptance by client. This work will include wiping of work areas, removal of streaks, dust, stains, etc., and assurances that systems and components as represented are new and undamaged.

### **3.9 TRAINING AND 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 keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets.
- B. Provide twelve hours of training and familiarization with the system. Schedule the training at the convenience of the Owner, in sessions of not more than four hours, unless previously agreed to with the designated representative of the Owner.

### **3.10 SYSTEM ACCEPTANCE**

- A. Obtain written acceptance from the Owner or the Owner's representative at the completion of system installation, testing, documentation and training. Failure of the contractor to obtain sign off will result in the contractor remaining responsible for extending, at no charge to the owner, conditions

of the warranty and guarantees until such time that sign off had occurred. Time included in the above condition will be presented to the owner in addition to the standard warranties.

**END OF SECTION**

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## **SECTION 27 41 00 - AUDIOVISUAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 WORK INCLUDED**

- A. Provide complete and operational Audiovisual (AV) systems as described in this document and as shown on associated drawings. Systems are to include plenum rated cables, accessories and miscellaneous items to ensure a complete and operational installation.
- B. Provide the plenum rated cabling, proper mounting, electrical termination, wiring within devices, junction boxes, device locations, associated equipment, hardware, firmware, and software.
- C. Provide materials in quantities sufficient for a complete installation(s) as indicated in drawings and in this specification, whether or not all such components are contained in the drawings and specifications.

#### **1.3 SUMMARY**

- A. The Audiovisual systems consist of furnishing and installing the audiovisual equipment, infrastructure necessary to support the Audiovisual equipment, connectivity, software, programming, accessories, and related items required to ensure complete and operational systems as described and as indicated in the drawings including:
  - 1. Wall blocking structural support for wall, surface, and flush mounted devices, and;
  - 2. Building secured, ceiling mounted mechanical structures and supports as required in open and closed ceilings for ceiling mounted devices, flanges, pipes, mounts, etc.;
  - 3. Electrical conduit and box rough-in as shown on the drawings;
  - 4. AV cable pulls as described, indicated on the drawings, or as otherwise required. These cables shall be installed within an infrastructure of electrical conduits, boxes, wall, floors, and ceiling, or as indicated, and/or required;
  - 5. Furnish and install video displays and/or projectors, wall mounts, ceiling mounts, projector ceiling mounts, projector wall mounts, projector threaded iron mounting pipes and associated flanges, brackets, trim, accessories, and supports.
  - 6. Projection screens, mechanical mounting structure and support for projection screen, screen case, motor, screen roller, screen surface, screen motor and control line-voltage wiring, and low voltage cable pulls related to the projection screen, and;
  - 7. Furnish and install speakers, rough-in-pans and back boxes in hard plaster and gypsum board ceiling locations, tile-bridge hardware in hung tile ceilings, and provide and install any other special permanently installed audiovisual items that require access to the building's infrastructure during the open-wall and open-ceiling phase(s) of the construction:
  - 8. Provide Audiovisual equipment, control systems, custom plates, plates, projectors, speakers, touch control panels, pushbutton control panels, custom engraved pushbuttons, custom machined and engraved plates, cameras, microphones, audio sources, video sources,

switchers, scalers, interfaces, displays, racks, workstations, custom furniture and lecterns, conferencing, power supplies, amplifiers, connectors, adapters, and related systems as shown on associated drawings. Systems shall include patch cables, in-rack jumpers, user interface cables, accessories and miscellaneous items to ensure a complete and operational turnkey installation.

9. Provide programming of equipment/systems, design and layout of touch-panel templates, programming of touch-panels, buttons, and controls, software installation, connectivity to LAN where necessary
- B. The work under this specification shall include the furnishing of all material, labor and the performance of all operations to provide a complete ready to use audiovisual systems in each and every space shown on the drawings, and as described herein.
- C. Furnish materials in quantities sufficient for a complete installation(s) as indicated in drawings and in this specification, whether or not all such components are contained in the drawings and specifications.
- D. Terminate cables as required per manufacturer's specifications to interface to all system devices.
- E. Provide touch control panel icon button and graphics templates showing arrangements and functions to conform to owner's standards, for owner review, prior to full control system programming. Make changes to touch panel layout, functionality, and icons, as coordinated with and described by the owner.
- F. The work of this section is work-for-hire. The software, licenses, programming, code, templates, notes, source code, and other work products are the property of the Owner and are to be delivered to the Owner as part of the project close-out submittals.
- G. Conference Room Systems:
- H. Board Room:
- I. Lobby and Reception Area Systems:
- J. Teleconferencing Systems:

#### **1.4 OBTAINING INFORMATION**

- A. Obtain the manufacturer's recommended installation practices, guidelines, and requirements.

#### **1.5 COORDINATION with project team**

- A. Provide a Project Manager who will act as a single point of contact for all activities regarding this project. The Project Manager must be a management employee and will not be involved in performing installation work.

#### **1.6 ACTION SUBMITTALS**

- A. Product Data:
  1. Provide a summary spreadsheet showing each item for each room and associated information identified below:
    - a. Item name
    - b. Manufacturer description
    - c. Manufacturer part number
    - d. Quantity required for the project



- e. Accessories and/or related items
  - f. "As specified" yes/no
  - g. If not as specified, provide "or equal" data
  - h. Page number in submittal package where item product information starts
2. For each item, provide manufacturer data sheets clearly marked to identify the specific item and configuration being submitted. Organize this information in the order identified in item 1.6.A.1 above.
- B. Shop Drawings:
1. Provide room layout drawings showing the devices, connections, cabling, and related information. Identify each device.
  2. Provide functional wiring diagrams for all audiovisual signals including: Audio, Video, Control, and Power & AV LAN wiring.
  3. Provide room cabling or cable riser diagrams for each system.
  4. Provide proposed Audiovisual equipment cabinet/rack elevations.
- C. Contractor Qualifications:
1. The Audiovisual Contractor shall be manufacturer certified and authorized, and manufacturer trained to distribute and install the submitted system equipment and components from the relevant manufacturer(s). Submit evidence of the following:
    - a. Manufacturer's authorization to supply product from the submitted system manufacturer with the bid response.
    - b. Manufacturer's authorization to officially represent the manufacturer's product warranty for the entire warranty period.
    - c. Three (3) references of work similar in type to that proposed herein. The references must be recent and accompanied by name of account, address, and contact name and telephone number.

## 1.7 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Include wiring room layouts, showing equipment mounting locations, pathways, and coordination with building systems.
- B. Control system graphics layouts for owner review and approval.
- C. Product Certificates: For each devices showing compliance with codes, standards, and project requirements.
- D. Field quality-control test reports.

## 1.8 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data: Provide operation, and maintenance manuals for each item/system.
- B. As-built drawings:
  1. Provide AutoCAD and PDF format, which show the actual construction conditions and configurations. Make all modifications to these drawings by removing all superseded data and show the completed "As-Built" installation.
  2. The "As-Built" drawings must be made available in the form of reproducible prints and an AutoCAD drawing file format for input to other systems. Maintain the as-built drawings throughout the project, and provide two hard copies, and electronic copies of the final conditions as-built drawings.
  3. Deliver the completed Record Drawings, identified above, properly titled and dated to the Owner labeled "As-Built" drawings. These drawings shall be completed and delivered two (2) weeks prior to the cutover and become the property of the Owner.

- C. Control Programming
  - 1. Furnish the documentation of last calibration in the form of a certificate and all test results as part of the "As-Built" package. Handwritten test results are not acceptable.
  - 2. Provide an editable copy of all control programs which will be property of the Owner. Programs may include but not be limited to:
    - a. Final Audio DSP files including gain settings, calibrated room EQ settings, microphone and assistive listening channel frequencies;
    - b. Video signal routing, videowall graphics processor settings;
    - c. Control System logic files with editable source code;
    - d. Control System graphical touchpanel files;
    - e. Custom calibration settings for projector, monitors, and video displays.
- D. Provide a list of necessary spare parts as recommended by the manufacturer to maintain and service the equipment being installed, and a schedule for obtaining and storing these parts.

## **1.9 FEES AND PERMITS**

- A. Obtain the necessary permits and pay all applicable fees.

## **1.10 QUALITY ASSURANCE**

- A. Verify actual conditions. Review the specifications and drawings, and advise in writing of any conditions, which may adversely affect the work, prior to the bid date. If no exceptions are presented, the Audiovisual Contractor shall become responsible for any changes to the work required as a consequence of such preexisting conditions.
- B. Material Provided:
  - 1. The Audiovisual Contractor shall furnish and install new manufacturer certified components.

## **1.11 WARRANTY**

- A. Provide a one (1) year warranty of the installed system against defects in material and workmanship. The warranty shall include response to the site to initiate a repair within 24 hours of a reported problem. The warranty offered shall be certified and honored by the system manufacturer(s). Labor and materials shall be provided at no expense to the Owner during normal working hours. The warranty period shall begin on the date of system acceptance by the Owner and/or Engineer. The warranty period will start upon the acceptance of the operational system(s) by the Owner, and the completion of training.
- B. Maintain a supply of necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being installed during the Warranty period.
- C. Provide an optional service contract offering continuing factory authorized service for two (2) years, for this system after the initial warranty period.

## **1.12 SUBMITTAL SUMMARY**

- A. The following is a summary table of the required submittals. It is provided as a reference, and is not a complete list of the required submittals, but provides guidance. Additional submittals may be required for the project. Refer to project documents for additional requirements. Submittals that require modification, replacement, additional information, and other changes are in addition to the submittals below, and are required as appropriate and/or required.

<b>Submittal</b>
Product Summary Spreadsheet
Product Data Sheets
Shop Drawings
Contractor Qualifications
Coordination Drawings
Product Certificates
Field Quality Control Test Reports
O&M Manuals
As-built Drawings
Spare parts for use by Owner
Software, licensing, Configuration Files etc.
Test Results
Warranty
Optional service contract proposal

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. The Audiovisual Contractor shall furnish all work referred to in this specification in compliance with National, State and Local codes. Material shall be furnished and installed in strict compliance with all requirements of these codes. Labor, materials, and systems supplied under this contract will be in full compliance with the NFPA 70 National Electrical Code, latest version.
- B. Provide complete and operational systems. The Audiovisual systems include, but are not limited to projection systems, projectors, monitors, LCD/LED/OLED/Plasma displays, video control systems and interfaces, lighting control systems, audio systems, unified conferencing systems, audioconferencing systems, video conferencing systems, speakers, amplifiers, microphones, switchers, speech reinforcement systems, assistive listening systems, control panels, wireless and remote touch screen controls, VCRs, DVDs, wiring, connectors, connections, accessories and miscellaneous equipment required to provide complete operational systems as indicated.

### **2.2 ADDITIONAL REQUIREMENTS**

- A. Ambient Light Control
  - 1. Provide connection to and integration with light control systems, shades, and other means of light control within spaces that are equipped with audiovisual systems.
- B. Effects from Building Vibration
  - 1. In cases where the audiovisual systems are or may be subject to vibration, and/or impacted by vibration, provide the solutions to remedy vibration include contracting with a vibration engineering specialist, assisting in making changes to the device or machinery creating the vibration and/or making changes to the building. Where vibration is affecting the audiovisual systems, provide vibration isolators, weights, bracing, dampener(s), cushions, springs, or vibration isolators.
- C. Interconnections to the fire alarm system
  - 1. Provide connections from the fire alarm system and emergency notification system to each of the audiovisual systems to override local programming in the event of an emergency;
  - 2. Equip each system with contacts, inputs, cabling, programming, and accessories to make the connection to the fire and emergency notification systems;

3. Provide the cabling from the fire and emergency notification systems to the audiovisual systems. Coordinate connection to the fire and emergency notification systems with the systems provider.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Meet with project manager, and other designated parties for a coordination meeting prior to commencement of work.
- B. Delivery, Storage, and Handling
  1. Maintain and protect materials in compliance with manufacturer's requirements and/or recommendations.
  2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
  3. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules.
  4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials. If directed by the Owner, discard of the packing material, containers, and other non-material items.
- C. Identification and Documentation
  1. All equipment cables and termination points will be clearly and permanently marked in accordance with standard audiovisual nomenclature and as presented in the working drawings.
  2. Labels are to be typed or printed on thermal transfer labeling system, dot matrix or laser printer using adhesive labels or other permanent marking strips. Hand printed labels are unacceptable.
- D. Examine drawings, details, and other sections of the specifications for requirements, which affect work under this section.
- E. Employ standard installation trade practices, including the following:
  1. All devices shall be securely mounted;
  2. There shall not be any exposed electrical connections on any devices;
  3. Exposed cabling is not acceptable;
  4. Provide conduit or raceway system for cabling within inaccessible (hard) ceiling areas and a surface conduit or raceway system for exposed (bare) ceiling areas, and a surface conduit or raceway system for vertical areas where cabling cannot be placed within walls (example: solid concrete);
  5. In suspended ceiling areas the cables shall be supported via wide base J-hooks attached to the existing building structure and framework at a maximum of four (4) foot intervals. Furnish and install CMP rated cable management straps required by code. Comply with the manufacturers' requirements for bending radius and pulling tension of all cables. Do not attach to lift out ceiling grid supports or lay directly on the ceiling grid;
  6. Do not attach to or support cables by fire sprinkler heads or delivery systems or any environmental sensor located in the ceiling air space;
  7. Use only those cables and wires or their equivalent types required for the devices listed for this particular installation;
  8. Cabling placed on this project shall be UL rated CMP, CL3P, or CL2P. Furnish and install systems including cable and hardware that complies with the requirements as outlined in the National Electric Code (NEC®) Articles 725, 760, 770, and 800 and the appropriate local codes. All copper cabling shall bear CMP UL designation;
  9. Wires and cables shall be clearly, logically and permanently identified with heat-shrink wire markers with machine-printed characters;

10. Provide joints and splices made with wire connectors, wire nuts, terminal blocks, or rosin-core soldered, where applicable. Cables are to be home run, without splices, unless otherwise noted. Acceptable splice points shall be enclosed in listed metal electric boxes, and shall utilize listed fittings to transition to cable, or listed conduit fittings as needed;
  11. Panel enclosures shall be enamel painted 16-gauge steel NEMA-1, hinged key-locking cover, with door tamper switch, mercantile grade enclosures;
  12. Conduits and Boxes: Comply with requirements in Division 26.
- F. Schedule, arrange, and coordinate with involved parties/trades for shipment (as applicable), arrivals, loading dock, elevators, acceptance, storage, and security of equipment and materials. Assure that these activities do not interfere with other trades or the progress of this project.
  - G. Provide the following miscellaneous items necessary to make a complete, functional, and satisfactory installation, including but not limited to patch cables, wire, connectors, terminals, adaptors, plugs, jacks, splitters, taps, mounting brackets, transformers, hardware fasteners, bezels, strain relief, bushings, adhesives, paints, gaskets, sealants, electrical tapes, fish paper and other insulation, rosin-core soldered connections, cable ties, shrinkable insulation, corrugated flexible tubing, engraved instructional plates and labeling, and secondary electrochemical batteries.
  - H. Provide technician coverage during installation of all related systems and hardware. Assist in required installation, testing and certification. Coverage requirements will be determined and scheduled by the owner, or owner's representative, in conjunction with provider of related hardware.

### **3.2 CODE COMPLIANCE**

- A. No penetrations to fire-rated structures are allowed without prior approval of the General Contractor.
- B. Fire stopping shall be done in an approved method where necessary to ensure the integrity of all fire-rated walls, ceilings, and floor penetrations effected by this installation.
- C. All cores and penetrations must be fire stopped in an approved method. All fire stop material must be qualified UL & ASTM-rated, meeting adequate FT requirements.
- D. Seal all openings between floors, through rated fire and smoke walls, existing or created by the Audiovisual Contractor for cable passage. Sealing material and application of this material shall be accomplished in such a manner that is complies with the manufacturer specification, National, State and Local codes.
- E. Furnish the necessary material and labor to create the necessary cores and other openings that are required for cable pathways.
- F. Furnish the necessary material and labor to seal all pathways created and /or utilized for the cable installation.
- G. The codes referred to in this specification are National, State and Local Electric Codes latest edition; all work shall be furnished and installed in strict compliance with the requirements of these codes.
- H. In the case of conflict between the Contract Documents and the Governing Code Ordinance, the more stringent standard shall apply.

### **3.3 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.

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. Provide all necessary test equipment and perform all work necessary to determine that the systems meet the requirements of this specification.
  2. Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts.
    - a. Use an appropriate Category Cable tester for structured cabling runs. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-B.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-B.1.
    - b. Use an appropriate Audio Impedance Meter capable of measuring VAC speaker loads up to 100k ohms to test for connectivity, load, and shorts. Measured loads should be equivalent to calculated loads while accounting for transformer and line loss.
    - c. Use an appropriate Video Test Generator capable of reproducing signals up to maximum resolution available for each video system. Confirm HDCP and EDID settings are correct.
  3. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
  4. 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.
  5. Test all wireless devices within the spaces to ensure they will operate as designed and that the optimum wireless channels have been chosen to avoid interference.
  6. Test the functional parameters of stand-alone devices and integrated interdependent equipment features. Test the systems and control systems. Provide written notice to the Engineer of intent to test systems at least one week prior to test.
  7. Conduct the operations of each system, sub-system, and component. Confirm that the sequence of operations and normal system functionality are observed. Modify the programming and installation to provide the required and specified operation.
- C. Devices and circuits will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports for submittal as described in Section 1.8 Closeout Submittals.

### **3.4 CLEANING**

- A. Clean all equipment and work areas of this scope. This work will include, but not be limited to wiping & dusting of work areas, removal of streaks, stains, and assurances that all systems and components as represented are new and undamaged.

### **3.5 OWNER TRAINING**

- A. Provide four hours of demonstration and orientation by a senior technician, or other qualified approved personnel, for each of the installed systems. Coordinate with the designated representative of the owner, and complete training the week prior to occupancy, or as scheduled with the owner. Demonstrate and explain:
  1. The physical configuration and interrelationship of the components of each system.

2. Labeling and interconnection techniques used in each installation.
  3. Applications or unique connections or interfaces currently in use on this site.
  4. A review of warranty documents for each system.
- B. Coordinate with the designated representative of the owner, and complete training the week prior to occupancy, or as scheduled with the owner.
- C. Provide four hours of training on the content of operating manuals, user guides, and record documentation for each system. Training for all systems will be provided at the project site and coordinated with the owner.
- D. Train using the equipment specified and installed under this document.

### **3.6 SYSTEM ACCEPTANCE**

- A. Sign-off for acceptance of system shall occur only after submission of final documentation of system including:
1. Test results indicate 100 percent functionality, and;
  2. System operation & maintenance manuals are transferred to the system owner, and;
  3. Training has been accomplished to the owner's satisfaction.
  4. Failure of the Audiovisual Contractor to obtain sign off will result in the Audiovisual Contractor remaining responsible for extending, at no charge to the owner, conditions of the warranty and guarantees until such time that sign off had occurred. Time included in the above condition will be included in the standard warranties.

**END OF SECTION**

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## **SECTION 28 10 00 - ELECTRONIC SECURITY SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections apply to work of this section.
- B. Division 8 Door Hardware: Electrified door lock types shown on the security drawings are not to be used for specifying or procuring door locks, or any other door or door frame hardware. The electrified door locks are to be specified by Division 8 Door Hardware. The door lock types shown on the security drawings are shown only for the purpose of coordinating electrical rough-in requirements related to the devices on door(s) and surrounding the frame(s).

#### **1.2 WORK INCLUDED**

- A. Provide complete and operational electronic security systems as described. Systems are to include plenum rated cables, accessories and miscellaneous items to ensure a complete and operational installation.
- B. Provide the plenum rated cabling, proper mounting, electrical termination, wiring within devices, junction boxes, device locations, associated equipment, hardware, firmware, and software.
- C. Provide materials in quantities sufficient for a complete installation(s) as indicated whether or not such components are specifically identified.

#### **1.3 SUMMARY**

- A. Access Control System: Provide an Access Control System, primarily consisting of the following devices, and as indicated:
  - 1. Credential Reader Stations;
  - 2. Access Control Door Processing Panels;
  - 3. Access Control Licenses per reader installed, and/or, per panel circuit board, as required by specific manufacturer's configuration, in order to provide a complete and operational system;
  - 4. Electronic hardware at doorways as indicated on the drawings for particular doorway configurations, including Egress Curtain Passive Infrared Motion Detectors and Magnetic Contacts;
  - 5. Access Control System Power Supplies and Relays;
  - 6. Electrochemical Batteries, sealed-lead acid type, and shall be capable of operating the DC portion of the access control system for a minimum period of 8 hours during an AC power failure, and maintaining secure locking of electromagnetically locked doors for a minimum of 70 hours;
  - 7. Electric Locks, Electric Strikes, Electrified Solenoid-Release Cylindrical and Mortise Locksets, Electromagnetic Locks, Electrified Latch Release Locks, and Request-to-Exit switches within door hardware by Division 8;
  - 8. Door Lock Power Supplies;
  - 9. High-current Latch-Retract power supplies by the Division 8;
  - 10. Door Release Pushbutton Switches, under-counter style, or as indicated;
  - 11. Request To Exit Palm Button Switches, Pneumatic Timer type, or as indicated;
  - 12. Cabling, connectors, terminations, and accessories;
  - 13. Access Control System:



- a. The system shall provide release of the hardwired electrical lock(s) upon presentation of a valid proximity credential.
  - b. The system shall provide computer control of card assignment and access configuration level templates, automatic door locking schedules, and audit print file generation.
  - c. Doorway locations shall consist of card readers, request-to-exit switches and/or door contacts, curtain motion detectors, and their wiring to access control panels, and low voltage wiring between door locks, door lock power supplies, and access control panels, networked together and to the main file server.
  - d. Provide processing of door contacts as alarm points per owner requirements.
- B. Intrusion Detection System: Provide an Intrusion Detection System, primarily consisting of the following devices:
1. Magnetic Contact Door Switches: 3/4 inch diameter, recessed-mount, normally-closed reed;
  2. Passive Infrared Motion Detectors, Ceiling mounted 360° pattern;
  3. Duress Buttons, Mechanical Latching with reset key;
  4. Inputs as required for connection to existing campus intrusion system
  5. Power Supplies and Relays;
  6. Communications modules and/or media converters for signal transmission to campus security
- C. Exit Alarm Panel System
1. Provide an exit alarm indicator panel at the main desk location to notify staff if an emergency-only exit is opened. The panel shall have visual and audible indicators and shall be capable of individual door zone override and silencing. The related doors shall also report to campus security (either via the alarm panel system, or via separate contacts, or multi-pole contacts)
- D. Video Security System: Provide a complete video security system, primarily consisting of the following devices:
1. IP Cameras, Day/Night, High-Resolution; fixed-view and panoramic, interior and exterior-rated
  2. Camera Lenses with indicated focal lengths;
  3. Camera Housings;
  4. Integrated Miniature Dome Cameras, convertible Flush/Surface Mounts;
  5. Camera Mounts;
  6. Camera Power Supplies and PoE Ethernet Switches;
  7. Monitor(s), High-Resolution;
  8. Video system licenses, per camera, and/or, per processing unit, as required by specific manufacturer's configuration, in order to provide a complete and operational system; Cabling, connectors, terminations, and accessories;
  9. Configure the existing Recording and Surveillance System Network Video Recorder (NVR) to digitally record all additional cameras. Provide an update as necessary to the existing recording system storage, sized to meet or exceed the following minimum parameters: 30 days of storage, compression method to be H.264, 7 Frames Per Second (FPS), full imager resolution (per each camera's imager size), integrated with a calculation of the maximum exterior low light hours using the darkness period for December 21 at the GPS coordinate of the site location, with 58.3% of motion (14 hours out of 24 hours with motion), and 15% unused storage to allow minor system expansion. The Security Contractor shall provide the NVR storage calculation as a submittal item. Provide a method whereby hard drive recorded video may be burned to a DVD or CD-R over the network at any time by the system owner. The System shall be connected to the facility's local area computer network (LAN) in order to allow remote storage, viewing, and playback. The system shall operate properly, completely unattended, and without the need for occasional manual rebooting.
- E. Intercom Systems

1. Provide Voice Intercom Master Station(s) and Vandal-Resistant Voice Door Substation(s) wired to provide point-to-point, and/or point-to-multipoint, voice communications. Provide power supplies and necessary cabling.
  2. Provide Video Intercom Master Station(s) and Vandal-Resistant Video Door Substation(s) wired to provide point-to-point, and/or point-to-multipoint, video and voice communications. Provide intercom central exchange(s), power supplies, and necessary cabling.
- F. Emergency Communications at Elevator Lobbies.
1. Provide handsfree speakerphone panels with braille and in-use indicator to communicate with campus security.

#### **1.4 OBTAINING INFORMATION**

- A. Obtain the manufacturer's recommended installation practices, guidelines, and requirements.

#### **1.5 COORDINATION with project team**

- A. Provide a Project Manager who will act as a single point of contact for activities regarding this project. The Project Manager must be a management employee and will not be involved in performing installation work.

#### **1.6 ACTION SUBMITTALS**

- A. Product Data:
1. Provide a summary spreadsheet showing each item and associated information identified below:
    - a. Item name
    - b. Manufacturer description
    - c. Manufacturer part number
    - d. Quantity required for the project
    - e. Accessories and/or related items
    - f. "As specified" yes/no
    - g. If not as specified, provide "or equal" data
    - h. Page number in submittal package where item product information starts
  2. For each item, provide manufacturer data sheets clearly marked to identify the specific item and configuration being submitted. Organize this information in the order identified in item 1.6.A.1 above.
- B. Shop Drawings:
1. Provide one-line diagrams showing the devices, connections, cabling, and related information. Identify each device, opening, and system.
  2. Wiring diagrams for each door style and interfaces/connections with the security devices.
  3. Written sequence-of-operations for each type of device, system, and zone, as indicated.
  4. System labeling schedules, including electronic copy of labeling schedules that are part of the cable and asset identification system of the software specified in Parts 2 and 3.
  5. Wiring Diagrams. For power, signal, and control wiring. Show typical wiring schematics including the following:
    - a. Control Panel Wiring;
    - b. Power Supply Wiring;
    - c. Data Connectivity;
  6. Cable Administration Drawings: As specified in "Identification" Article.
  7. Battery and charger calculations.
- C. Contractor Qualifications:

1. The Security Contractor shall be manufacturer certified and authorized, and manufacturer trained to distribute and install the submitted system equipment and components from the relevant manufacturer(s). Submit evidence of the following:
  - a. Manufacturer's authorization to supply product from the submitted system manufacturer with the bid response;
  - b. Manufacturer's certification of the Security Contractor's technicians assigned to this project;
  - c. Proper state licensing for each Security Technician assigned to this job with the bid response;
  - d. Manufacturer's authorization to officially represent the manufacturer product warranty for the entire warranty period;
  - e. Three (3) references of work similar in type to that proposed herein. The references must be recent and accompanied by name of account, address, and contact name and telephone number.

#### **1.7 INFORMATIONAL SUBMITTALS**

- A. The Security Contractor shall provide the NVR storage calculation along with the NVR product submittal.
- B. Coordination Drawings: Include MDF, IDF, wiring room layouts, showing equipment mounting locations, pathways, and coordination with building systems.
- C. Product Certificates: For each devices showing compliance with codes, standards, and project requirements.
- D. Field quality-control test reports.

#### **1.8 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: Provide operation, and maintenance manuals for each item/system.
- B. As-built drawings:
  1. Provide AutoCAD and PDF format, which show the actual construction conditions and configurations. Make modifications to these drawings by removing all superseded data and show the completed "As-Built" installation;
  2. The "As-Built" drawings must be made available in the form of reproducible prints and an AutoCAD drawing file format for input to other systems. Maintain the as-built drawings throughout the project, and provide two hard copies, and electronic copies of the final conditions as-built drawings;
  3. Deliver the completed Record Drawings, identified above, properly titled and dated to the Owner labeled "As-Built" drawings. These drawings shall be completed and delivered two (2) weeks prior to the cutover and become the property of the Owner.
- C. Provide spare parts as recommended by the manufacturer to maintain and service the equipment being installed.
- D. Provide software including configuration files, codes, and passwords.

#### **1.9 FEES AND PERMITS**

- A. Obtain the necessary permits and pay applicable fees.

**1.10 QUALITY ASSURANCE**

- A. Verify actual conditions. Review the specifications and drawings, and advise in writing of any conditions, which may adversely affect the work, prior to the bid date. If no exceptions are presented, the Security Contractor shall become responsible for any changes to the work required as a consequence of such preexisting conditions
- B. Material Provided:
  - 1. The Security Contractor shall furnish and install new manufacturer-certified components

**1.11 WARRANTY**

- A. Provide a one (1) year warranty of the installed system against defects in material and workmanship. The warranty shall include response to the site to initiate a repair within 24 hours of a reported problem. The warranty offered shall be certified and honored by the system manufacturer(s). Labor and materials shall be provided at no expense to the Owner during normal working hours. The warranty period shall begin on the date of system acceptance by the Owner and/or Engineer. The warranty period will start upon the acceptance of the operational system(s) by the Owner, and the completion of training.
- B. Provide an optional service contract offering continuing factory authorized service for two (2) years after the initial warranty period.
- C. Maintain a supply of necessary spare parts in the proper proportion as recommended by the manufacturer to maintain and service the equipment being installed during the warranty period.

**1.12 Submittal Summary**

- A. The following is a summary table of the required submittals. It is provided as a reference, and is not a complete list of the required submittals, but provides guidance. Additional submittals may be required for the project. Refer to project documents for additional requirements. Submittals that require modification, replacement, additional information, and other changes are in addition to the submittals below, and are required as appropriate and/or required.

<b>Submittal</b>
Product Summary Spreadsheet
Product Data Sheets
NVR Recording System Storage Calculation
Shop Drawings
Contractor Qualifications
Coordination Drawings
Product Certificates
Field Quality Control Test Reports
O&M Manuals
As-built Drawings
Spare parts for use by Owner
Software, licensing, Configuration Files etc.
Test Results
Warranty
Optional service contract proposal

## **PART 2 - PRODUCTS**

### **2.1 GENERAL**

- A. The Security Contractor shall furnish work referred to in this specification in compliance with National, State and Local codes. Material shall be furnished and installed in strict compliance with requirements of these codes. Labor, materials, and systems supplied under this contract will be in full compliance with the NFPA 70 National Electrical Code, latest version.

### **2.2 CABLE, HARDWARE, components, and systems**

- A. Provide cable, components, materials, systems, and hardware requirements, as indicated.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Meet with project manager, and other designated parties for a coordination meeting prior to commencement of work.
- B. Delivery, storage, and handling:
  - 1. Maintain and protect materials in compliance with manufacturer's requirements and/or recommendations.
  - 2. Open each container; verify contents against packing list; and file copy of packing list, complete with container identification, for inclusion in operation and maintenance data.
  - 3. Mark packing list with the same designations assigned to materials and equipment for recording in the system labeling schedules that are generated by software specified in "Cable and Asset Management Software" Article.
  - 4. Save original manufacturer's containers and packing materials and deliver as directed under provisions covering extra materials.
- C. Identification and documentation:
  - 1. Equipment cables and termination points will be clearly and permanently marked in accordance with standard audio/visual nomenclature and as presented in the working drawings.
  - 2. Labels are to be typed or printed on thermal transfer labeling system, dot matrix or laser printer using adhesive labels or other permanent marking strips. Hand printed labels are unacceptable.
- D. Examine drawings, details, and other sections of the specifications for requirements, which affect work under this section.
- E. Employ standard installation trade practices, including the following:
  - 1. Devices shall be securely mounted;
  - 2. There shall not be any exposed electrical connections on any devices or sensors;
  - 3. Exposed cabling is not acceptable;
  - 4. Provide conduit or raceway system for cabling within inaccessible (hard) ceiling areas and a surface conduit or raceway system for exposed (bare) ceiling areas, and a surface conduit or raceway system for vertical areas where cabling cannot be placed within walls (example: solid concrete);
  - 5. In suspended ceiling areas the cables shall be supported via wide base J-hooks attached to the existing building structure and framework at a maximum of four (4) foot intervals. Furnish and install CMP rated cable management straps required by code. Comply with the

- manufacturers' requirements for bending radius and pulling tension of cables. Do not attach to lift-out ceiling grid supports or lay directly on the ceiling grid;
6. Do not attach to or support cables by fire sprinkler heads or delivery systems or any environmental sensor located in the ceiling air space;
  7. Use only those cables and wires or their equivalent types required for the devices listed for this particular installation;
  8. Cabling placed on this project shall be UL rated CMP, CL3P, or CL2P. Furnish and install systems including cable and hardware that complies with the requirements as outlined in the National Electric Code (NEC®) Articles 725, 760, 770, and 800 and the appropriate local codes. All copper cabling shall bear CMP UL designation;
  9. Wires and cables shall be clearly, logically and permanently identified with heat-shrink wire markers with machine-printed characters;
  10. Provide joints and splices made with wire connectors, wire nuts, terminal blocks, or rosin-core soldered, where applicable. Cables are to be home run, without splices, unless otherwise noted. Acceptable splice points shall be enclosed in listed metal electric boxes, and shall utilize listed fittings to transition to cable, or listed conduit fittings as needed. Door contact wiring splices (outside of metal electric boxes) shall be full insulated and covered with heat shrinkable insulation;
  11. Panel enclosures shall be enamel painted 16-gauge steel NEMA-1, hinged key-locking cover, with door tamper switch, mercantile grade enclosures;
  12. Conduits and Boxes: Comply with requirements in Division 26;
  13. Provide end-of-line resistors at the supervised device;
  14. Passive infrared detectors shall be sealed, including the point of cable entry, to discourage insect nesting and false tripping from air drafts;
  15. Duress buttons shall be mounted in exact locations as coordinated with the Designer;
  16. Metal Oxide Varistors spike suppression devices shall be installed at all electric lock coils;
  17. Electric strikes, electrified solenoid-release cylindrical and mortise locksets, electromagnetic locks, electrified latch-enable locksets, and electrified delayed-egress latch-release locking devices shall utilize minimum #18/2 jacketed, copper cable for cable runs up to 300'. Runs greater than 300' from power supply and reader to these style locks shall utilize copper conductor cable that is sized so that the calculated voltage drop is less than 3 percent of the power supply voltage;
  18. DC electric-latch crash bar retraction solenoids shall utilize a power supply local to the door locking mechanism, wired through appropriately sized, jacketed copper cable. The Security Contractor shall provide secondary relays as necessary, wired to the access control panel in a cascaded fashion, in order to control the high lock current. The access control panel relays shall only be utilized as pilot relays;
  19. Intrusion Sensors and Detectors shall be wired using minimum #22/4 conductor solid cable with jacket, and shall be have the appropriately fire-rated insulation as required in the location of the cable run(s). Runs from power supply to active devices shall utilize copper conductor cable that is sized so that the calculated voltage drop is less than 3 percent of the power supply voltage.
- F. Electrified door hardware that is fail safe, shall be properly connected to Fire Alarm Interface Relays, which are a UL Listed component of the building's Fire Alarm System (to be supplied by others). The Security Contractor shall provide for the complete tie-in to the Fire Alarm System, including any cable runs between the access control security equipment and the Fire Alarm System locations, and to provide for any relays or Fire Alarm interface modules. The Security Contractor shall be responsible for coordination location of these relays with the Fire Alarm System Contractor, and connecting to the "access control" side of the relays.
- G. Provide the following miscellaneous items necessary to make a complete, functional, and satisfactory installation, including but not limited to hookup wire, patch cables, switches, connectors, terminals, adapters, plugs, jacks, mounting brackets, hardware fasteners, bezels, escutcheons, strain relief, bushings, adhesives, paints, gaskets, sealants, electrical tapes, rosin-core soldered connections, cable ties, shrinkable insulation, corrugated flexible tubing, labeling, and secondary electrochemical batteries.

- H. Schedule, arrange, and coordinate with involved parties/trades for shipment (as applicable), arrivals, loading dock, elevators, acceptance, storage, and security of equipment and materials. Assure that these activities do not interfere with other trades or the progress of this project.
- I. Protect materials according to manufacturer's specifications.
- J. Provide hardware of one manufacturer, where practical, for each defined system and/or classification of material.
- K. Furnish and install new and unused materials and equipment including those parts/components that might be replaced during the warranty period.
- L. Provide plenum rated cables in strict compliance with NFPA 70, National Electrical Code, Article 725 and 800 requirements for individual conductor and overall jacket insulation material type(s).
- M. Provide the following miscellaneous items necessary to make a complete, functional, and satisfactory installation, including but not limited to patch cables, wire, connectors, terminals, adaptors, plugs, jacks, splitters, taps, mounting brackets, transformers, hardware fasteners, bezels, strain relief, bushings, adhesives, paints, gaskets, sealants, electrical tapes, fish paper and other insulation, rosin-core soldered connections, cable ties, shrinkable insulation, corrugated flexible tubing, engraved instructional plates and labeling.
- N. Training:
  - 1. Provide four hours of demonstration and orientation by a senior technician, or other qualified approved personnel, for each of the installed systems. Coordinate with the designated representative of the owner, and complete training the week prior to occupancy, or as scheduled with the owner.
    - a. Demonstrate and explain:
      - 1) The physical configuration and interrelationship of the components of each system.
      - 2) Labeling and interconnection techniques used in each installation.
      - 3) Applications or unique connections or interfaces currently in use on this site.
      - 4) A review of warranty documents for each system.
  - 2. Provide a minimum of 2 hours additional training for system users for each shift of a 24-hour operational facility, for a total of 6 hours of training during three (3) individual site visits. Clear user documentation shall be provided by the Security Contractor for each training session. Training shall be conducted by a knowledgeable security installation technician, and shall occur during times coordinated with and acceptable to the system owner.
  - 3. Provide four hours of training on the content of operating manuals, user guides, and record documentation for each system. Training for systems will be provided at the project site and coordinated with the owner.
  - 4. Provide the training using the equipment specified and installed under this document.
  - 5. Obtain written acceptance from the owner or the owner's representative at the completion of system(s) installation, testing, documentation and training. Failure of the Security Contractor to obtain sign off will result in the Security Contractor remaining responsible for extending, at no charge to the owner, conditions of the warranty and guarantees until such time that sign off had occurred. Time included in the above condition will be included in the standard warranties.
- O. Provide technician coverage during installation of related systems and hardware. Assist in required installation, testing and certification. Coverage requirements will be determined and scheduled by the owner, or owner's representative, in conjunction with provider of related hardware.

### **3.2 CODE COMPLIANCE**

- A. No penetrations to fire-rated structures are allowed without prior approval of the General Contractor.

- B. Fire stopping shall be done in an approved method where necessary to ensure the integrity of fire-rated walls, ceilings, and floor penetrations effected by this installation.
- C. Cores and penetrations must be fire stopped in an approved method. Fire stop material must be qualified UL & ASTM-rated, meeting adequate FT requirements.
- D. Seal openings between floors, through rated fire and smoke walls, existing or created by the Security Contractor for cable pass. Sealing material and application of this material shall be accomplished in such a manner that is complies with the manufacturer specification, National, State and Local codes.
- E. Furnish the necessary material and labor to create the necessary cores and other openings that are required for cable pathways.
- F. Furnish the necessary material and labor to seal pathways created and/or utilized for the cable installation.
- G. The codes referred to in this specification are National, State and Local Electric Codes latest edition; work shall be furnished and installed in strict compliance with the requirements of these codes.
- H. In the case of conflict between the Contract Documents and the Governing Code Ordinance, the more stringent standard shall apply.

### **3.3 GROUNDING AND BONDING**

- A. Furnish and install all grounding and bonding material. The grounding and bonding shall meet the National Electrical Code (NEC®) as well as local codes, which specify additional grounding and/or bonding requirements.

### **3.4 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Tests and Inspections:
  1. Cable Procedures: Inspect for physical damage and test each conductor signal path for continuity and shorts. Use an appropriate Category Cable tester for structured cabling runs. Test for faulty connectors, splices, and terminations. Test according to TIA/EIA 568-B.1, "Commercial Building Telecommunications Cabling Standards - Part 1: General Requirements." Link performance for UTP cables must comply with minimum criteria in TIA/EIA 568-B.1.
  2. Test each circuit and component of each system. Tests shall include, but are not limited to, measurements of power-supply output under maximum load, signal loop resistance, and leakage to ground where applicable. System components with battery backup shall be operated on battery power for a period of not less than 10 percent of the calculated battery operating time. Provide special equipment and software if testing requires special or dedicated equipment.
  3. 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.
  4. Test the functional parameters of stand-alone devices and integrated interdependent equipment features. Test the systems and control systems. Provide written notice to the Engineer of intent to test systems at least one week prior to test.



5. Conduct the operations of each system, sub-system, and component. Confirm that the sequence of operations and normal system functionality are observed. Modify the programming and installation to provide the required and specified operation.
- C. Devices and circuits will be considered defective if they do not pass tests and inspections.
  - D. Prepare test and inspection reports for submittal as described in Section 1.8 Closeout Submittals.

### **3.5 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to supervise and assist with startup service.
  1. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
  2. Enroll and prepare badges and access cards for Owner's operators, management, and security personnel.

### **3.6 CLEANING**

- A. Clean all equipment and work areas of this scope. This work will include wiping of work areas, removal of streaks, stains, and assurances that all systems and components as represented are new and undamaged.

### **3.7 SYSTEM ACCEPTANCE**

- A. Sign -off for acceptance of the system shall occur only after submission of final documentation of system including:
  1. Test results indicates 100 percent functionality, and;
  2. System operation manuals and documentation are transferred to the system owner, and;
  3. Training has been accomplished to the owner's satisfaction

**END OF SECTION**

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## **SECTION 28 31 05 - FIRE ALARM CABLES AND PATHWAYS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Fire alarm cables.
  - 2. Fire-resistive fire alarm cables.
  - 3. Fire alarm terminal cabinets.
  - 4. Fire alarm raceway and boxes.

#### **1.3 DEFINITIONS**

- A. Dedicated Continuous Metal Raceway: Enclosed metal pathway dedicated to power-limited fire alarm cable; comprised of and limited to: EMT, IMC, RGS, FMC, and / or LFMC as specified.

#### **1.4 SUBMITTALS**

- A. Comply with Division 28 for "Pre-installation Submittals".
- B. Product Data: For each fire alarm cable application, including cable type, wire size, shielding, and electrical characteristics.
  - 1. Include statement endorsed by the manufacturer's authorized representative that the electrical characteristics of the submitted fire alarm cables are within all operating parameters of the fire alarm system as designed and represented by the detailed fire alarm system Shop Drawings.
- C. Product Data: For fire alarm terminal cabinets, including furnished options and accessories.
- D. Record of Inspection and Testing: For field wiring inspection and testing; for each circuit indicate measured values and corresponding acceptance criteria for circuit continuity, resistance, stray voltage, ground-faults, short-circuit-faults, and any other manufacturer recommended conductor field testing parameters.

#### **1.5 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 FIRE ALARM CABLES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Anixter Inc.
  - 2. Belden Inc.
  - 3. Southwire Co.
  - 4. West Penn Wire.
- B. Fire Alarm Cable: UL 1424, Type FPL, power-limited fire alarm cable; red-jacketed, twisted-pair and parallel-pair insulated solid copper conductors; unshielded and shielded.
- C. Fire Alarm Metal-clad Cable: UL 1424, Type MC-FPLP, power-limited fire alarm cable; jacketed, twisted-pair solid copper conductors with red aluminum interlocking outer armor jacket; unshielded and shielded.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Red Alert MC-FPLP cable, manufactured by Southwire Co.
- D. Minimum Fire Alarm Cable Conductor Size:
  - 1. Auxiliary (24 Vdc) Power: 14 AWG / 2C.
  - 2. Data Communications Network: 16 AWG / 2C.
  - 3. Digital Voice Riser: 16 AWG / 2C.
  - 4. Notification Appliance Circuits: 14 AWG / 2C.
  - 5. Relay Circuits: 14 AWG / 2C.
  - 6. RS Serial Data Communications: 18 AWG / 2C.
  - 7. Signaling Line Circuits: 16 AWG / 2C.
  - 8. Speaker Circuits: 16 AWG / 2C.
  - 9. Supervision Circuits: 16 AWG / 2C.
- E. Data and Voice Circuits:
  - 1. Fire alarm cable for Data Communications Network, Digital Voice Riser, Signaling Line Circuits, Speaker Circuits, RS Serial Data Communications, and other manufacturer-specific data and voice circuits shall be shielded, twisted-pair unless fire alarm manufacturer's installation guidelines recommend or require unshielded twisted-pair cable.
  - 2. Fire alarm cable electrical characteristics for Data Communications Network, Signaling Line Circuits, RS Serial Data Communications, and other manufacturer-specific data circuits shall comply with the fire alarm manufacturer limitations for linear-unit and total-circuit capacitance and resistance.

### **2.2 FIRE-RESISTIVE FIRE ALARM CABLES**

- A. Multi-conductor Fire-resistive Cable: UL 2196 fire resistive, Type FPL, power-limited fire alarm cable; ceramifiable silicon insulation; jacketed, solid copper conductors; unshielded and shielded.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Duralife FPL fire resistive alarm cable, manufactured by Radix Wire Co.

### **2.3 FIRE ALARM TERMINAL CABINETS**

- A. Enclosure: 16 gauge steel; factory applied red enamel finish; removable hinged door with keyed locking latch; with embedded 1/2 inch, 3/4 inch, 1 inch, 1-1/2 inch and 2 inch knockout clusters.
- B. Terminals: Each terminal pole with quick-connect wire termination points and integral test port; sized to accept 20 - 12 AWG and rated for 20 amp at 250V (Class B/UL) 300V (CSA).

- C. Identification: Marked "FIRE ALARM TERMINAL CABINET" in 2 inch white factory applied indelible screened lettering; field identification labels on the inside cover corresponding to the terminal strip's labeling inside the back box.
- D. Basis-of-Design Product: Subject to compliance with requirements, provide IF-Series fire alarm terminal cabinets, manufactured by Space Age Electronics Inc.

## **2.4 FIRE ALARM RACEWAY AND BOXES**

- A. Comply with Division 26.
  - 1. Finish: Factory applied red finish for cover plates and connectors.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Comply with NFPA 70 and NFPA 72.
- B. Unless more restrictive requirements are noted in Division 28, comply with applicable Division 26 sections for the installation of low voltage electrical systems.
- C. Comply with Division for NFPA 72 pathway Class and Survivability Level requirements.
- D. Install fire alarm system pathways and cables in accordance with the reviewed fire alarm system Shop Drawings. Where field modifications of layout are necessary, obtain prior approval from the fire alarm system vendor's qualified fire alarm system designer.

### **3.2 FIRE ALARM PATHWAY INSTALLATION**

- A. Pathways for Fire Alarm: The pathway system for fire alarm shall be dedicated continuous metal raceway throughout.
  - 1. Comply with Division 26 for application and installation of EMT, IMC, RGS, FMC, and LFMC with respect to environmental conditions and resistance to physical damage.
- B. Pathways beneath Slab, Within Slab, and Buried: Comply with Division 26 for applicable RNC installation requirements.
- C. Class A and X Pathways: Unless greater distances are indicated on the Drawings or Specifications, install Class A and X pathways in compliance with NFPA 72 recommendations for minimum horizontal and vertical separation between supply and return pathways.

### **3.3 FIRE RESISTIVE PATHWAY INSTALLATION**

- A. Where NFPA 72 Survivability Level 2 or 3 pathways (2-hr fire resistance rated) are indicated or required, provide one of the following:
  - 1. UL 1424 fire alarm cable installed within 2-hr fire resistance rated shaft construction or similar 2-hr rated building construction.
  - 2. UL 2196 fire resistive fire alarm cable (Category FHJR) installed within metal raceway in accordance with the corresponding UL "Circuit Integrity System" (Category FHIT).
  - 3. UL 1424 fire alarm cable installed within metal raceway protected by an endothermic wrap assembly installed in accordance with the corresponding UL "Circuit Integrity System" (Category FHIT).

- a. Basis-of-Design Product: Interam Endothermic Mat, manufactured by 3M.

### **3.4 FIRE ALARM CABLE INSTALLATION**

- A. Install fire alarm cables within dedicated continuous metal raceway throughout. Wiring shall be continuous between equipment, device, and appliance terminals without splices.
- B. T-tapping: Not permitted for any fire alarm circuit.
- C. Do not install fire alarm system wiring within conduits, junction boxes, or outlet boxes containing conductors of lighting or power systems.
- D. Separate power-limited and non-power-limited conductors within enclosures as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess.
- E. 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 system's wiring diagrams.
- F. Not more than two conductors shall be installed under any device screw terminal. The wires under the screw terminal shall be straight when placed under the terminal then clamped in place under the screw terminal. The wires shall be broken and not twisted around the terminal.

### **3.5 GROUNDING**

- A. Comply with Division 26.

### **3.6 FIELD QUALITY CONTROL**

- A. Field inspections and testing shall be performed by fire alarm system manufacturer's factory-authorized service technicians.
- B. End-to-end cabling shall be considered defective if it does not pass tests and inspections.
- C. Perform visual wiring inspections in accordance with fire alarm system manufacturer recommendations. Correct deficiencies.
- D. Test wiring in accordance with fire alarm system manufacturer requirements and NFPA 72 for Initial Acceptance Testing of conductors. Correct deficiencies.
- E. Document inspections and tests via formal inspection test and report(s).

**END OF SECTION**

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## **SECTION 28 31 11 - DIGITAL, ADDRESSABLE FIRE ALARM SYSTEM**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Certain requirements common to all the mechanical and electrical trades (Fire Suppression, Plumbing, HVAC, Electrical, and Tele/Data) are specified in Division 20. To avoid repetition, they are not repeated in each relevant Division of the Specifications. However, these requirements are applicable to the work of this Division, and are hereby incorporated by reference.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Fire alarm control units.
  - 2. Emergency voice messaging components.
  - 3. Remote annunciators.
  - 4. Remote graphic annunciators.
  - 5. Local operating consoles.
  - 6. Power supplies.
  - 7. Network communications.
  - 8. Digital alarm communicator transmitters.
  - 9. Internet protocol (IP) communicators.
  - 10. Manual fire alarm boxes.
  - 11. System detectors.
  - 12. Non-system detectors.
  - 13. Single station smoke alarms.
  - 14. Notification appliances.
  - 15. Addressable interface modules.
  - 16. Fault isolation modules.
  - 17. Magnetic door holders.
  - 18. Surge protection devices.
  - 19. Maintenance bypass switches.
  - 20. System printers.

#### **1.3 DEFINITIONS**

- A. ADS: Acoustically Distinguishable Space.
- B. AHJ: Authority Having Jurisdiction.
- C. BMS: Building Management System.
- D. EVACS: Emergency Voice Alarm Communication System.
- E. FACU: Fire Alarm Control Unit.
- F. FATC: Fire Alarm Terminal Cabinet.
- G. IDC: Initiating Device Circuit.

- H. NAC: Notification Appliance Circuit.
- I. NICET: National Institute for Certification in Engineering Technologies.
- J. PSTN: Publically Switched Telephone Network.
- K. SLC: Signaling Line Circuit.

#### **1.4 SUBMITTALS**

- A. Comply with Division 20 for common mechanical/electrical requirements.
- B. Comply with Division 28 specifications and drawings; state/local regulations; and NFPA 72 - Chapter "Documentation". For purposes of applying NFPA 72, all identified documentation requirements are a mandatory part of the Work, including those that "apply only where required by other governing laws, codes, or standards, by other parts of the Code; or by project specifications or drawings".
- C. Submit "Pre-installation Submittals" prior to applying for authority having jurisdiction installation permits (where required) and system installation.
- D. Submit "Approval Testing Submittals" after successful initial system testing and prior to scheduling authority having jurisdiction final approval demonstration testing.
- E. Submit "Closeout Submittals" as part of project closeout procedure.

#### **1.5 PRE-INSTALLATION SUBMITTALS**

- A. Qualification Data: For Designers and Field Technicians.
  - 1. Include NICET certifications and fire alarm system manufacturer training certifications.
- B. Product Data: For each type of product, including furnished options and accessories.
  - 1. Include approvals and listings, construction details, material descriptions, dimensions, profiles, and finishes.
  - 2. Include rated capacities, operating characteristics, and electrical characteristics.
  - 3. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements of this Specification and of NFPA 72.
- C. Seismic Qualification Certificates: For fire alarm control unit, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity 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.
- D. Sample Warranty: For special warranty.
- E. Shop Drawings: For fire alarm system and fire safety control interfaces.
  - 1. Floor Plans. Include floor plans to indicate final equipment, cabinet, device and appliance locations. Indicate address of each addressable device. Show all interface modules. Show candela setting for each strobe appliance. Show complete point-to-point routing of all circuits and pathways; indicate Class and Survivability Level. Show size and type of all conduits, cable, wire, and conductors. Indicate panel circuit designation for each normal power supply branch circuit.

2. Riser Diagram. Include complete device/appliance accurate riser diagram. Indicate address of each addressable device. Show all interface modules. Show candela setting of each strobe appliance. Show each circuit and pathway; indicate Class and Survivability Level. Show size and type of all conduits, cable, wire, and conductors. Indicate panel circuit designation for each normal power supply branch circuit.
3. Equipment Wiring Diagrams. Include wiring diagrams for each system component/node including control unit cabinets, remote power supply cabinets, terminal cabinets, remote annunciators, supervising station transmitters, and PC workstations.
4. Component Wiring Diagrams. Include typical wiring diagrams for fire detector bases, pull stations, conventional devices, interface modules including wiring connections to supervised/controlled equipment, notification appliances, and component modules and cards.
5. Ductwork Smoke Detector Plans. Include installation details for each ductwork detector condition. Show plan and section view for each condition. Show requirements for ductwork attachments, penetrations, and access panels.
6. Calculations - Voltage Drop. Include voltage drop calculations inclusive of safety/spare capacity factor(s) for notification-appliance circuits. Calculations shall assume alarm operation using the minimum standby power available at the conclusion of quiescent and alarm phases of operation.
7. Calculations - Power Supply and Battery Capacity. Include power capacity calculations inclusive of safety/spare capacity factor(s) for each system power supply and connected battery set.
8. Calculations - Conduit Fill. Include conduit fill calculations prepared in accordance with the National Electric Code.
9. Sequence of Operation. Include complete and detailed input/output sequence of operation matrix. Supplement matrix with narrative descriptions for complex specialty sequences.

F. Delegated-Design Submittals – RESERVED.

## **1.6 APPROVAL TESTING SUBMITTALS**

- A. Statement of Completion: Written statement that system has been installed in accordance with approved plans and tested in accordance with the manufacturer's published instructions and appropriate NFPA 72 requirements.
- B. Record of Inspection and Testing. Detailed documentation of completed 100 percent fire alarm and signaling system initial acceptance testing. Use NFPA 72 "System Record of Inspection and Testing" forms.

## **1.7 CLOSEOUT SUBMITTALS**

- A. Record of Completion. Provide detailed description of installed, tested, and approved fire alarm and signaling system; including description of protected premises, fire alarm system and component sub-systems, fire safety function interfaces, monitoring service, and all other information required by NFPA 72. Use NFPA 72 "System Record of Completion" forms.
- B. Record Drawings. Provide complete Shop Drawing re-submittal updated to reflect actual final system installation and sequence of operation of all components.
- C. Device address list. Provide complete device address list organized by SLC loop and system node.
- D. Operation and Maintenance Data: For fire alarm systems and components to include in emergency, operation, and maintenance manuals.
  1. Provide manufacturer's Owner's Operation and Maintenance Manuals with required related system warranty requirements.



2. Provide NFPA 72 "Inspection, Testing, and Maintenance" tables indicating required component inspection and testing activities and frequencies.
  3. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
- E. Software and Firmware Operational Documentation:
1. Provide software operating and upgrade manuals.
  2. Site-specific Software Backup: Provide on compact solid state USB storage device or compact disk; complete with data files.

## **1.8 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Smoke Detectors and Heat Detectors: Five (5) of each type installed.
  2. Detector Bases: Five (5) of each type installed.
  3. Audible and Visual Notification Appliances: Five (5) of each type installed.
  4. Keys and Tools: One extra set for access to locked or tamper-proof components.
  5. Fuses: Two (2) of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

## **1.9 QUALITY ASSURANCE**

- A. Field Technician Qualifications: Personnel trained and certified by the fire alarm system manufacturer as an approved technician.
- B. Designer Qualifications: Shop Drawings and Calculations prepared by personnel certified by NICET as fire alarm Level III or IV technician.
- C. Source Limitations for Fire alarm System and Components: Single vendor source to provide fire alarm system components and connected non-system components as a single listed addressable fire alarm and signaling system.
1. Modifications to Existing Systems: Components compatible with, and operate as an extension of, existing system.
- 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.
1. Specific Agency Requirements for All Products: Underwriters Laboratories (UL) listed and Factory Mutual (FM) Approved.
- E. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

## **1.10 PROJECT CONDITIONS - RESERVED**

## **1.11 SEQUENCE AND SCHEDULING - RESERVED**

## **1.12 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace fire alarm system equipment and components that fail in materials or workmanship within specified warranty period.
1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.

2. Warranty Period: Five (5) years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Subject to compliance with requirements, provide products listed as a component of a single addressable fire alarm and signaling system technology platform by one of the following:
  1. Notifier; a Honeywell company.
- B. Where additional manufacturer listings or basis of design products are indicated, provide products listed and duty-rated as compatible with the selected fire alarm and signaling technology platform.

### **2.2 SYSTEM DESCRIPTION**

- A. UL 864; non-coded, microprocessor-based addressable protected premises fire alarm and signaling system, with multiplexed signal transmission and audible/visual evacuation signaling. All components provided listed for use and compatible with fire alarm system head-end FACU.
- B. Protected premises backbone architecture comprised of multiple fire alarm control units and system components networked via peer-to-peer communications node network.
- C. Control units, system components, and power supplies inclusive of boards, drivers, and expansion modules necessary to support the specified system performance criteria, minimum quantity of circuits, and NFPA 72 circuit pathway class designations.
- D. System circuiting and component power loading to provide minimum specified spare capacities, safety factors, and redundancies.
- E. Special Alarm Signal Processing – RESERVED.
- F. NFPA 72 Pathway Class (Performance During Fault) and Survivability Level (Fire Resistance):
  1. Addressable signaling loops.
    - a. Circuit Type: SLC.
    - b. Pathway Class: B.
    - c. Class A Short-circuit Fault Isolation Modules or Bases Located as Follows:
      - 1) At each SLC exit/entry point of from/to a control unit or terminal cabinet.
      - 2) No more than twenty (20) addressable devices between isolation modules at any point on SLC.
    - d. Pathway Survivability Level: 1.
  2. Audible public mode signaling (occupant evacuation).
    - a. Circuit Type: NAC.
    - b. Pathway Class: B.
    - c. Pathway Survivability Level: 1.
  3. Visible public mode signaling (occupant evacuation).
    - a. Circuit Type: NAC.
    - b. Pathway Class: B.
    - c. Pathway Survivability Level: 1.
  4. Audible and visible private mode signaling.
    - a. Circuit Type: NAC.
    - b. Pathway Class: B.
    - c. Pathway Survivability Level: 1.
  5. Supervision of conventional devices.
    - a. Circuit Type: IDC.
    - b. Pathway Class: B.

- c. Pathway Survivability Level: 1.
  - 6. Fail-safe operation, magnetic door holders and similar.
    - a. Circuit Type: Fail safe.
    - b. Pathway Class: D.
    - c. Pathway Survivability Level: 1.
  - 7. Communication between fire alarm network nodes.
    - a. Circuit Type: Comm.
    - b. Pathway Class: X.
    - c. Pathway Survivability Level: 3.
  - 8. Class N – RESERVED.
- G. All addressable circuits designed and installed without T-taps.
  - H. Maximum 100 addressable alarm-initiating devices on each SLC.
  - I. Component Primary Power: 24-V dc obtained from premises AC power supply.
    - 1. Capacity: Alarm current draw of components connected to each power-supply module no greater than 80 percent of the power-supply module rating.
  - J. Component Standby Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
    - 1. Base Capacity: System operation for twenty-four (24) hours under quiescent load plus five (5) minutes operating all alarm notification appliances.
    - 2. Spare Capacity: 20 percent.
  - K. Remote power supplies used as distributed power sources only and not as in-line circuit power “boosters”.
  - L. Complete end-to-end fire alarm system interfaces with other premises building systems including Fire Suppression, HVAC, Vertical Transportation, Audio/Visual, Public Address, Access Control, Fire Protection Opening Protectives, Emergency Power, and similar for all code-required and project-specified fire safety supervision and functional control.
  - M. Complete fire alarm system end-to-end control and supervision of building smoke control system(s) including automatic operation, manual operation, and indication of smoke control system component status. Comply with UL 864 UUKL.
  - N. Retransmission of protected premises alarm, supervisory, and trouble status signals (Contact ID format) to an AHJ approved alarm supervising station.

### **2.3 PERFORMANCE REQUIREMENTS**

- A. Operational Performance: Fire alarm system shall process alarm, supervisory, and trouble status signals and perform associated output functions in compliance with NFPA 72, Division 28 and Drawings “Input/Output Matrix”.
- B. Circuit Integrity and Fault Performance: Fire alarm system circuit integrity and functional performance capability under fault conditions shall comply with the NFPA 72 circuit Class designations as indicated within the “System Description” Article and as indicated on the Drawings.
- C. Survivability Performance: Fire alarm system fire resistive performance capability shall comply with the NFPA 72 circuit Level designations as indicated within the “System Description” Article and as indicated on the Drawings.
- D. Seismic Performance: Fire alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. 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."

## 2.4 FIRE ALARM CONTROL UNITS

- A. General: UL 864; power-limited, field-programmable, microprocessor-based, modular design. Inter-connected power supplies, circuit board modules, displays, and associated electronics mounted to standard mounting chassis within common control unit cabinet enclosure. Control unit cabinet assemblies configured as control units with integral display and controls or as transponder units with solid door and no local display/controls.
- B. Central Processors and System Software:
  1. Central Processing Unit (CPU): Solid-state processor for processing and storage of system status and event signal data and execution of control-by-event and logic software functions; with real-time clock for time annotation of events accurate to second time-increments.
  2. Memory: System software, event history logs, and programs held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
  3. Software Programming: Programmable via local FACU display and controls and also via externally connected laptop/PC programming application. Passwords required to access software program, one (1) "Master" password for highest level of permissions for use by authorized technicians and multiple "User" passwords for lower level permissions for use by general facilities personnel.
  4. Alarm Signal Processing:
    - a. General: General alarm actuation of notification appliances, emergency control function interface devices, and annunciation at the protected premises within 10 seconds of initiating device alarm activation.
    - b. Smoke Detector Verification: Capability to password-enable individual addressable smoke detectors to include a maximum 60 second verification phase.
    - c. Pre-signal Alarm Sequence: Capability to password-enable system such that protected premises general alarm functions are delayed for more than 60 seconds after receipt of initial alarm signal; general alarm functions may be initiated automatically or by human action after delay.
    - d. Positive Alarm Sequence: Capability to password-enable system such that protected premises general alarm functions are delayed for no more than 15 seconds to permit manual acknowledgement of signal. If signal is not acknowledged within 15 seconds general alarm operation automatically initiates. If signal is acknowledged within 15 seconds, general alarm is delayed for up to 180 seconds to permit investigation. If fire alarm control unit is not reset within the investigation time-delay general alarm operation automatically initiates. If a second initiating device is activated during the investigation time-delay, general alarm operation automatically initiates.
  5. Software Zones: General alarm zone, releasing zone, and special logic zones used to map system inputs from assigned addressable device(s) to corresponding system output(s).
  6. Time-Function Control: Capability to assign 24-hr clock time-dependent logic to event functions for time delay feature and/or automatic function scheduling to specific day of the week or year.
  7. Non-Fire Events: Capability to assign "Non-Fire" ID category to module addresses such that assigned event functions are executed without indication at the FACU display.
  8. Walk test: Test modes to permit system testing under bypass mode.
- C. Display and Controls:
  1. General: Display and controls arranged for interface between human operator and fire alarm system including system status indication, event status indication, manual query inputs, manual programming inputs, and manual output functions.
  2. Event Display: LCD; minimum 2 lines, 40 characters.

3. Status Indicators: LED indicators for indication of system status; with corresponding membrane switch buttons to acknowledge incoming alarm, supervisory and trouble event signals.
  4. Audible Indicator: Piezo sounder for audible indication of system status and incoming event signals; silenced upon signal acknowledge.
  5. Keypad: Alpha-numeric entry and LCD navigation keys for display scrolling, item selection, system programming, and similar manual user operations.
  6. Function-key Modules: Membrane switch buttons used to initiate assigned software function, each with corresponding LED indicators for indication of function status.
- D. Signaling Line Circuit Controllers:
1. SLC Loop Capacity: Minimum 125 addressable initiating devices and 125 addressable modules (250 addressable devices total) per loop.
  2. Degrade Mode: Upon CPU communication failure, controllers capable of stand-alone function mode permitting alarm operation during communication fault condition.
  3. Configuration: Capable of supporting Class A or Class B SLC configuration.
- E. Serial Interfaces: RS 232, RS 485 or approved equivalent for communication with system annunciators, printers, graphics displays, digital controllers, and similar distributed system components; USB ports for laptop configuration of system and file download to USB data storage devices.
- F. Cabinet Enclosures: Steel back-box with top, bottom, and side knockouts for 1/2-inch through 2-inch metal raceway; manufacturer's chassis rails for electronics mounting; key-lock latching, left or right swing hinged, removable steel front door panel with and without view panel(s); with trim accessories for flush mount where indicated in Part 3 "Equipment Installation" and Drawings; steel box and door surfaces in factory-finish red enamel.

## **2.5 REMOTE ANNUNCIATORS**

- A. General: Display and controls remote from Fire Alarm Control Unit arranged for interface between human operator and fire alarm system including system status indication, event status indication, manual query inputs, manual programming inputs, and manual output functions.
- B. Event Display: LCD; minimum 2 lines, 40 characters.
- C. Status Indicators: LED indicators for indication of system status; with corresponding membrane switch buttons to acknowledge incoming alarm, supervisory and trouble event signals.
- D. Audible Indicator: Piezo sounder for audible indication of system status and incoming event signals; silenced upon signal acknowledge.
- E. Keypad: Alpha-numeric entry and LCD navigation keys for display scrolling, item selection, system programming, and similar manual user operations.
- F. Function-key Modules: Membrane switch buttons used to initiate assigned software function, each with corresponding LED indicators for indication of function status.
- G. Enclosure: Comply with Article "Fire Alarm Control Units" for enclosures.

## **2.6 POWER SUPPLIES**

- A. General: Switched-mode supervised power supply base and expansion modules supplying regulated and filtered 24-V dc power to system components, notification appliances, and auxiliary power loads.

- B. FACU Applications: Power supply modules and batteries mounted within Fire Alarm Control Unit (FACU) equipment cabinets to provide integral system power to chassis-mounted components, connected notification appliance circuits, and connected auxiliary power circuits; batteries located within stand-alone battery cabinet for high-capacity applications.
- C. RPS Applications: Power supply modules and batteries mounted within distributed Remote Power Supply (RPS) equipment cabinets to provide supplemental power to connected notification appliance circuits and connected auxiliary power circuits.
- D. Primary Power Supply: 120-V ac.
- E. Secondary Power Supply: 24-V dc supply system including sealed lead acid batteries, automatic float-charge battery charger, and automatic transfer switch.
- F. Outputs: Programmable for operation as Notification Appliance or Auxiliary Power circuits; NAC outputs capable of operation as sync-generator or sync-follower; capable of supporting Class A or Class B circuit configuration.
- G. Supervision: Loss of primary power, low battery power, battery charger failure, and output circuit fault conditions supervised by fire alarm system via serial communication or system SLC supervision of trouble contacts.
- H. Cabinet Enclosures: Comply with Article "Fire Alarm Control Units" for cabinet enclosures.

## **2.7 NETWORK COMMUNICATIONS**

- A. Provide network communications for fire-alarm system nodes and peripherals according to fire-alarm manufacturer's written requirements.

## **2.8 DIGITAL ALARM COMMUNICATION TRANSMITTERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Same manufacturer as the selected manufacturer of the fire alarm and signaling system technology platform.
  2. Bosch Security Systems Inc.
  3. Digitize, Inc.
  4. Keltron Corp.
- B. General: UL 864 digital alarm communicator transmitter (DACT) compatible with supervising station receiving equipment; module mounted within FACU cabinet or within stand-alone enclosure; with onboard status LED indicators for component and signal transmission status.
- C. Signal Input Connections: Serial connection to host FACU.
- D. Signal Transmission Connections: Primary and secondary loop-start telephone lines; programmable such that both phone lines report to the same telephone number, or such that each phone line reports to a different telephone number.
- E. Transmission Format: Selectable for Contact ID, SIA, or 4/2 Pulse formats.
- F. Supervision: DACT system trouble status supervised by host FACU via serial interface or DACT auxiliary contacts.
- G. Self-Test: Conducted automatically every 24 hours with report transmitted to supervising stations.
- H. Programming: Remotely via serial interface or integral programming key pad with LED display.

- I. Power Supply: Primary 24-V dc obtained from premises AC power supply or host FACU power supply module. Standby 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch provided with DACT unit or as part of host FACU standby power supply system.

## **2.9 IP COMMUNICATORS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Same manufacturer as the selected manufacturer of the fire alarm and signaling system technology platform.
  - 2. Bosch Security Systems Inc.
  - 3. Digitize, Inc.
  - 4. Keltron Corp.
- B. General: UL 864 IP communicator (native-IP module or IP-dialer-capture module) compatible with supervising station receiving equipment; module mounted within FACU cabinet or within stand-alone enclosure; with onboard status LED indicators for component and signal transmission status.
- C. Signal Input Connections: Serial connection to host FACU or telephone line connections to host FACU-DACT.
- D. Signal Transmission Connections: 10/100 Base network ethernet reporting to primary and secondary IP addresses; dynamic DCPH or static IP supported.
- E. Transmission Format: Selectable for Contact ID, SIA, or 4/2 Pulse formats converted to encrypted UDP protocol data transmission.
- F. Supervision: IP Communicator system trouble status supervised by host FACU via serial interface, FACU-DACT telephone line interface, or IP Communicator auxiliary contacts.
- G. Self-Test: Supervisory heart beat signal of no less than once every 90 seconds to supervising station to ensure multiplexed level line supervision.
- H. Programming: Remotely via serial interface or integral programming key pad with LED display.
- I. Power Supply: Primary 24-V dc obtained from premises AC power supply or host FACU power supply module. Standby 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch provided with DACT unit or as part of host FACU standby power supply system.

## **2.10 MANUAL FIRE ALARM BOXES**

- A. General: UL 38; red finish, with molded, raised-letter operating instructions and "FIRE" identification in contrasting color; shall show visible indication of operation.
- B. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral or attached addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire alarm control unit.
- C. Station Reset: Key- or wrench-operated switch.
- D. Indoor Protective Cover: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible sounder intended to discourage false-alarm operation.

- E. Weatherproof Protective Cover: Factory-fabricated, clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

## **2.11 SYSTEM FIRE DETECTORS**

- A. General: Analog addressable system smoke, system heat, or other system detectors for sensing products of combustion; listed as compatible with fire alarm system control unit and with integral addressable module capable of two-way analog communication with fire alarm control unit permitting remote sensitivity control, identification of device address, alarm status, trouble status, and trending of maintenance data.
- B. Detector Housing: Low profile, white-polycarbonate thermoplastic, impact resistant, and flame retardant detector housing for mounting into twist-lock base; with LED indicator for indication of detector status-poling (flashing) or in operation (constant).
- C. Detector Bases: Ceiling- and wall-mount, low profile, white-polycarbonate thermoplastic, impact resistant, and flame retardant plastic twist-lock fixed base; with terminals for SLC conductor terminations.
  - 1. Auxiliary Detector Bases: Optional bases furnished to perform supplemental detector-local functions.
    - a. Sounder bases to provide local audible alarm at detector; 24-V dc.
    - b. Relay bases for output control of associated equipment.
    - c. Isolation bases to isolate short circuit faults on SLC.
    - d. UL 2075 carbon monoxide sensor and associated distinct audible alarm and visual indicator.
- D. Remote Alarm Indicators (RAI): LED visual indicator in flush-mount plate, connected to corresponding detector base terminals for remote indication of detector alarm.
- E. Remote Test Station (RTS): RAI with key operated test switch for remote detector testing.
- F. Operating Voltage: 24-V dc nominal for detectors and auxiliary bases; 120-V ac rated contacts for relay bases as per application.
- G. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

## **2.12 SYSTEM SMOKE DETECTORS**

- A. Comply with "System Fire Detectors" Article.
- B. UL 268, photoelectric spot-type with insect-screen protected sensing chamber; for installation in twist-lock system bases.
- C. Operating Temperature Range: 32 – 100 deg F (0 – 38deg C).
- D. Operating Humidity Range: 10 - 95 percent RH.
- E. Sensitivity Range: 0.2 - 3.7 percent obs/ft.
- F. Air Velocity Rating: 0 - 4,000 fpm (0 - 1220 mpm).



## **2.13 SYSTEM IN-DUCT SMOKE DETECTORS**

- A. UL 268A, photoelectric spot-type system smoke detector listed for installation directly within air distribution ductwork; with and without integral output relays.
- B. Mounting: For square and round ducts via factory furnished mounting kit or standard electrical raceway and boxes as per detector manufacturer requirements.
- C. Air Velocity Range: 0 - 4,000 fpm (0 - 1,220 mpm).

## **2.14 SYSTEM SAMPLING TUBE DUCT SMOKE DETECTORS**

- A. Comply with "System Fire Detectors" Article.
- B. UL 268A, photoelectric spot-type system smoke detector listed for installation within detector housing mounted to exterior surface of air distribution ductwork, with connected sampling tubes transporting ductwork air to the external detector sensing chamber; with and without integral output relays.
- C. Mounting: For square and round ducts via factory furnished mounting kit.
- D. Air Velocity Range: 300 - 4,000 fpm (91 - 1,220 mpm).

## **2.15 WEATHERPROOF DUCT SMOKE DETECTORS - RESERVED**

## **2.16 SYSTEM HEAT DETECTORS**

- A. Comply with "System Fire Detectors" Article.
- B. UL 521, spot type heat detector actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless other temperature rating(s) are indicated on Drawings.

## **2.17 SYSTEM CARBON MONOXIDE DETECTORS**

- A. Comply with "System Fire Detectors" Article.
- B. UL 2075 carbon monoxide sensor integral to fire detector housing or as an auxiliary detector base; and permitting distinct addressable point identification of smoke alarm and/or carbon monoxide alarm at each detector. Audible and visible CO indicators distinct from smoke and heat detector indicators.

## **2.18 SYSTEM MULTI-CRITERIA DETECTORS**

- A. Comply with "System Fire Detectors" Article.
- B. Multi-criteria fire detector utilizing multiple sensing elements and correlating detection algorithms permitting initiation of alarm upon detection of individual sensing elements or in combination.
  - 1. Photoelectric smoke sensor - comply with "System Smoke Detectors" Article.
  - 2. Heat sensor - comply with "System Heat Detectors" Article.
  - 3. Carbon monoxide sensor - comply with "System Carbon Monoxide Sensors" Article.

## **2.19 NOTIFICATION APPLIANCES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Same manufacturer as the selected manufacturer of the fire alarm and signaling system technology platform.
  - 2. Edwards Signaling.
  - 3. System Sensor.
  - 4. Wheelock, Cooper Industries.
- B. General Performance Requirements for Notification Appliances: Signaling appliances connected to notification appliance circuits for NFPA 72 public operating mode signaling to building occupants protected by the fire alarm system; and private operating signaling to those persons directly concerned with implementation and direction of emergency action and procedures. Appliance assemblies include audible, visible, and combination type as indicated on Drawings.
- C. Mounting: Wall or ceiling mount as indicated on Drawings.
- D. Housing: Thermoplastic, impact resistant, and flame retardant.
- E. Finish: White housing with Red contrasting engraved lettering.
- F. Identification: Engraved lettering on housing indicating "FIRE".
- G. Weather proof applications: Listed for indoor and outdoor installation.

## **2.20 AUDIBLE NOTIFICATION APPLIANCES**

- A. Comply with "Notification Appliances" Article.
- B. Horns: UL 464, electric-vibrating-polarized type horn within dedicated housing, 24-V dc; listed sound-pressure level of 90 dBA measured 10 feet (3 m).
- C. Bells: UL 464; 6 inch diameter, vibrating motor type bell, 24-V dc; red finish, listed for indoor and outdoor applications.

## **2.21 VISIBLE NOTIFICATION APPLIANCES**

- A. Comply with "Notification Appliances" Article.
- B. Strobes: UL 1971, xenon strobe with clear polycarbonate lens mounted on an aluminum faceplate and field selectable candela output setting within dedicated housing, 24-V dc; with candela setting indicator visible through viewing window.
  - 1. Strobe flashing in temporal pattern, synchronized throughout each evacuation zone and synchronized between evacuation zones where strobes from multiple evacuation zones can be observed by a single viewer.
  - 2. Comply with Drawings for appliance candela output.
- C. Flashing Beacons: UL 1638; 6 inch diameter, red lens beacon, 24-V dc; listed for indoor and outdoor applications.

## **2.22 COMBINATION AUDIBLE AND VISIBLE NOTIFICATION APPLIANCES**

- A. Combination audible and visible notification appliance with audible and visible signaling elements assembled within a common housing.

1. Audible horn - comply with "Audible Notification Appliances" Article.
2. Visible strobe - comply with "Visible Notification Appliances" Article.

## **2.23 ADDRESSABLE INTERFACE MODULES**

- A. General: Microelectronic interface module for supervision and control of premises fire safety functions with integral address-setting means, internal code for FACU identification by module type, and output contact ratings to match controlled/supervised equipment.
- B. Monitor Module: Provides a system address for alarm-initiating devices for wired applications with normally open contacts.
- C. Relay Module: Capable of providing a direct output signal to controlled equipment or device.
  1. Allows the FACU to switch the relay contacts on command.
  2. Minimum of two normally open and two normally closed contacts available for field wiring.
- D. Control Module: Capable of providing a supervised direct output signal to controlled notification appliance, equipment or device.
  1. Allows the FACU to switch the relay contacts on command.
  2. Minimum of two normally open and two normally closed contacts available for field wiring.

## **2.24 FAULT ISOLATION MODULES**

- A. Module capable of sensing and automatically isolating SLC short circuit fault.

## **2.25 MAGNETIC DOOR HOLDERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Bosch Security Systems Inc.
  2. Rixson, Yale Security Inc.
  3. RSG Inc.
- B. Description: Normally powered hold opens, fail-closed; equipped for wall or floor mounting and complete with matching doorplate.
  1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
  2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
  3. Operating Voltage: 120-V ac.
- C. Material and Finish: Match door hardware.

## **2.26 SURGE PROTECTIVE DEVICES**

- A. General: UL 497B, hybrid gas discharge tube/diode technology surge protective devices; listed for power-limited fire alarm circuit applications intended to prevent component damage or nuisance alarms induced by lightning strikes, stray currents, or voltage transients.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Citel America Inc.
  2. Ditek Corp.
  3. Space Age Electronics, Inc.
  4. Transtector Systems, Inc.

## **2.27 MAINTENANCE BYPASS SWITCHES**

- A. Description: Keyed or push-button operated switches to open connected circuits that permit system testing without operating associated auxiliary fire safety functions. Activated switches shall annunciate as a trouble condition at the fire alarm control unit. Include trim plate with LED indicators factory-marked "NORMAL" and "DISABLE".

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Prepare and submit "Pre-Installation Submittals" prior to equipment procurement.

### **3.2 EXAMINATION**

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
  - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Confirm fire resistance rating of building construction required to perform as fire alarm system Survivability protection before installation.
- C. Examine depth of stud walls to verify clearance for flush-mount equipment before installation.
- D. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- E. Examine proposed mounting locations of equipment cabinets with user displays and/or controls with the local fire official to verify satisfactory access and ease of identification before installation.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.3 EXISTING SYSTEM REMOVAL AND IMPAIRMENTS - RESERVED**

### **3.4 EQUIPMENT INSTALLATION**

- A. Comply with the most restrictive requirements of this Section and applicable Division 26 sections for the installation of low voltage electrical systems.
- B. Comply with NFPA 72, and requirements of authorities having jurisdiction for installation and testing of fire alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
- C. Arrange equipment cabinets, wire-ways, and conduits with adequate clearances to facilitate access for inspection, maintenance, and component replacement.
- D. Install equipment cabinets with top and bottom of cabinets not more than 72 inches (1980 mm) above finished floor and not less than 12 inches (305 mm) above finished floor, respectively.

- E. Install battery cabinets with top and bottom of cabinets not more than 48 inches (1220 mm) above finished floor and not less than 12 inches (305 mm) above finished floor, respectively.
- F. Install fire alarm system modules and auxiliary components in accessible locations with bottom of modules and components not less than 12 inches (305 mm) above finish floor.
- G. Install equipment cabinets with user displays and/or controls including fire alarm control unit nodes and remote annunciators with displays and/or controls at natural user height.
- H. Flush-mount equipment cabinets/back-boxes not located in designated equipment rooms.
- I. Flush-mount wall- and ceiling-mounted initiating devices, modules, indicators, and notification appliances unless otherwise indicated.
- J. Surface-mount equipment cabinets/back-boxes located in designated equipment rooms.
- K. Surface-mount initiating devices, modules, indicators, and notification appliances installed on concrete or masonry unit walls.
- L. Surface-mount initiating devices installed to the underside of building structure.
- M. Surface-mount or pendant-mount notification appliances installed to the underside of structure.
- N. Install ceiling mounted devices, modules, indicators and notification appliances in alignment with adjacent ceiling fixtures and centered within ceiling tiles.
- O. Install wall mounted devices, modules, indicators and notification appliances in alignment with adjacent switches and wall fixtures.
- P. Do not install addressable devices in areas subject to temperature extremes. Use conventional initiating devices supervised by addressable monitor modules remotely located within an adjacent conditioned space.
- Q. Weather-proof – RESERVED.
- R. Storefront/Curtainwall Installation – RESERVED.
- S. Pedestal Installation – RESERVED.

### **3.5 CABLE AND PATHWAY INSTALLATION**

- A. Comply with Division 28.

### **3.6 INSTALLATION FOR SURVIVABILITY**

- A. Where NFPA 72 Survivability Level 2 or 3 pathways are indicated or required, install fire alarm system cables and pathways within 2-hr fire resistance rated enclosures or comply with Division 28 for “Fire Resistive Pathway Installation”.
- B. Install control units, amplifiers, power supplies, junction boxes, terminal cabinets, or similar components within dedicated 2-hr fire resistance rated fire alarm system equipment rooms where the components originate or comprise a portion of a NFPA 72 Survivability Level 2 or 3 pathway.

### **3.7 MANUAL FIRE ALARM BOX INSTALLATION**

- A. Install manual fire alarm boxes in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
- B. Install manual fire alarm boxes with operable handles between 42 inches (1060 mm) and 48 inches (1220 mm) above finish floor level.
- C. Install all manual fire alarm boxes at a common elevation with respect to finished floor.
- D. Install manual fire alarm boxes on a background of a contrasting color.

### **3.8 SYSTEM SPOT-TYPE FIRE DETECTOR INSTALLATION**

- A. Locate spot-type fire detectors in a manner that readily permits access – without the need of a lift - from the floor below for detector inspection, testing, and maintenance.
- B. Install fire detectors only after all dust and debris producing work is completed.
- C. Maintain factory provided detector covers on fire detectors until fire alarm system is approved for closeout and turnover.
- D. Install Remote Alarm Indicators in a visible location for each group of fire detector located within a normally locked room or area.
- E. Spot-type Smoke- and Heat-Detector Locations and Spacing:
  - 1. Comply with Drawings, and;
  - 2. Comply with NFPA 72 "Smoke-Sensing Fire Detectors".
  - 3. Comply with NFPA 72 "Heat-Sensing Fire Detectors".

### **3.9 INSTALLATION OF AIR DISTRIBUTION DUCTWORK DETECTORS**

- A. Comply with NFPA 72, International Mechanical Code, and NFPA 90A.
- B. Install duct smoke detectors in accordance with manufacturer's installation guidelines.
- C. Locate duct detectors in a manner that readily permits access for detector inspection, testing, and maintenance.
- D. Plan and coordinate duct detector locations and mounting requirements with Division 23 prior to ductwork fabrication and installation; show coordinated duct detector layout on Coordination Drawings and Shop Drawings.
- E. Furnish duct detector housings and ductwork attachments for installation under Division 23. Coordinate requirements for ductwork penetrations, attachments, sealant, and access panels with Division 23.
- F. Do not install duct detectors, housings, or sampling tubes in ductwork until all dust and debris producing work is complete and air distribution system cleaning and startup is complete. Duct detector housings may be attached to ductwork and connected to SLC/IDC prior to air distribution system startup provided they are protected from dust and debris using factory covers.
- G. Air Distribution Equipment Shutdown Applications: Use sampling-tube type system duct smoke detectors.
  - 1. Supply Air Systems: Locate duct smoke detectors downstream of fans and filters.

2. Return Air Systems: Locate duct smoke detectors upstream of filters, exhaust air connections, outdoor air connections or decontamination equipment.
- H. Fire/Smoke Damper Control Applications: Where dampers are provided with conventional duct smoke detectors integral to the fire/smoke dampers (Division 23) supervise duct smoke detector alarm and trouble contacts via addressable interface modules.
  - I. Fire/Smoke Damper Control Applications: Use in-duct (spot type) system smoke detectors that do not require a minimum air-stream velocity to operate.
    1. Locate duct smoke detectors within 5 ft (1.5 m) of the associated damper.
    2. Locate and support duct smoke detectors in accordance with manufacturer's installation guidelines.
  - J. Install remote alarm test stations at each duct detector in readily accessible location that does not interfere with other sections of the Work.

### **3.10 CARBON MONOXIDE DETECTOR INSTALLATION - RESERVED**

### **3.11 NOTIFICATION APPLIANCE INSTALLATION**

- A. Comply with Drawings and NFPA 72 "Notification Appliances".
- B. Wall-mounted Audible Notification Appliances: Install with top of appliance not less than 6 inches (150 mm) below the finished ceiling and not less than 90 inches below the finished floor.
- C. Wall-mounted Visible and -Combination Audible/Visible Notification Appliances: Install with top of appliance not less than 6 inches (150 mm) below the finished ceiling and the entire appliance strobe lens not less than 80 inches and not more than 96 inches above the finished floor.
- D. Install all wall-mounted notification appliances with top of appliance at a common elevation with respect to finished floor.
- E. Install exterior flashing beacons such that they are clearly visible from the primary fire department vehicle access route; and as indicated on Drawings. Use a dedicated NAC for each beacon.
- F. Install exterior alarm bells adjacent to each sprinkler fire department inlet connection; and as indicated on Drawings. Use a dedicated NAC for each bell.

### **3.12 CONNECTIONS AND INTERFACES**

- A. Make connections to premises building systems and components via addressable interface modules. Include necessary interface modules, relays, wiring, resistors, and components as required to achieve the input/output sequence of operations performance criteria indicated by the Drawings.
- B. Coordinate voltage and current ratings of connected components such that connections and interfaces operate within listed limitations. Use interposing relays where connected loads exceed rating of addressable interface modules.
- C. Arrange connections and interfaces such that circuits are monitored for integrity as required by NFPA 72.
- D. Interface to premises systems and components requiring fire alarm supervision of status with addressable interface monitor modules.

- E. Interface to premises Preaction Sprinkler solenoids and/or Fire Extinguishing System actuators with addressable interface control modules listed for releasing service. Install a key operated maintenance disconnect switch in the releasing circuit to permit fire alarm system component testing without solenoid/actuator release. Operation of the maintenance disconnect switch be monitored by the fire alarm system as a supervisory condition.
- F. Interface to premises systems and components requiring Emergency Control Function Interface with addressable interface relay modules installed within 36 inches of the interface wiring termination point.
- G. Each addressable interface relay module used for Emergency Control Function Interface shall include one (1) set of spare contacts for monitoring connection to the premises Building Management System, Security System, or similar secondary premises system.
- H. For each HVAC air distribution unit, coordinate with Division 23 for exact interface requirements, quantity of fan drives, and detailed sequencing for proper shutdown of the associated air distribution equipment.
- I. Supervising Station – RESERVED.

### **3.13 IDENTIFICATION**

- A. Identify system components, wiring, cabling, and terminals. Comply with Division 26.
- B. Label addressable initiating devices and bases and notification appliances. Comply with Drawings.
- C. Install framed instructions adjacent to the fire alarm control unit. Installed instructions shall be typewritten computer printout instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

### **3.14 GROUNDING**

- A. Comply with Division 26.
- B. Comply with fire alarm system manufacturer installation guidelines for grounding.
- C. Ground fire alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire alarm control unit

### **3.15 FIELD QUALITY CONTROL**

- A. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Devices placed in service before all other trades have completed cleanup shall be replaced.
- C. Field inspections and testing shall be performed by fire alarm system manufacturer's factory-authorized service technicians.
- D. Smoke Control Systems: In addition to Div. 28 fire alarm system inspection and testing requirements, perform additional inspections and integrated functional testing as required to support smoke control system Special Inspections commissioning.



- E. Prepare a typewritten computer-output Test Plan that clearly establishes the scope of fire alarm and signaling system testing. Include at a minimum testing methods, personnel, duration, planned impairments, and required coordination for integrated testing of emergency control function interfaces.
- F. Functional field tests shall be witnessed by the Construction Manager (CM) and their designees; provide notifications a minimum of two (2) weeks in advance.
- G. Acceptance field testing shall be witnessed by the CM, their designees, and authorities having jurisdiction (AHJ); provide notifications a minimum of two (2) weeks in advance.
- H. Perform visual inspections in accordance with fire alarm system manufacturer recommendations and NFPA 72 for Initial Acceptance Inspections. Correct deficiencies.
- I. Document inspections by completing applicable sections of the NFPA 72 "System Record of Inspection and Testing" report.
- J. Provide written notifications for functional field tests; include Test Plan.
- K. Perform functional testing in accordance with fire alarm system manufacturer recommendations and NFPA 72 for "Initial Acceptance Testing". Correct deficiencies. Repeat functional testing including retesting of unaffected components in accordance with NFPA 72 for "Reacceptance Testing".
- L. Document 100 percent satisfactory functional tests by completing remaining sections of the NFPA 72 "System Record of Inspection and Testing" report.
- M. Submit NFPA 72 "Statement of Completion" and completed NFPA 72 "System Record of Inspection and Testing" report.
- N. Provide written notifications for acceptance field tests; include Test Plan, NFPA 72 "Statement of Completion", NFPA 72 "System Record of Inspection and Testing" report, and NFPA 72 "System Record of Completion".
- O. Perform acceptance field testing. Demonstrate system operation to the satisfaction of the AHJ. Correct AHJ noted deficiencies. Repeat functional testing including retesting of unaffected components in accordance with NFPA 72 for "Reacceptance Testing". Amend NFPA 72 "System Record of Inspection and Testing" report, and NFPA 72 "System Record of Completion".
- P. Place system into normal operating service without system faults or outstanding work.

### **3.16 MAINTENANCE SERVICE**

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include twelve (12) months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  1. Perform visual inspections at intervals required by NFPA 72 Chapter "Inspection, Testing, and Maintenance".
  2. Perform tests at intervals required by NFPA 72 Chapter "Inspection, Testing, and Maintenance".

### **3.17 SOFTWARE SERVICE AGREEMENT**

- A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

- B. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.
  - 1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

### **3.18 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire alarm system.

**END OF SECTION**

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## **SECTION 31 10 00 – SITE PREPARATION**

### **PART 1 - GENERAL**

#### **1.1 SCOPE OF WORK**

- A. Clearing site of debris designated for removal in preparation for site and building earthwork.
- B. Protection of existing structures indicated in Contract Drawings to remain.
- C. Installation and maintenance of roadway construction signage and associated traffic measures.
- D. Implementation of specified and any other measures deemed necessary or required by governing authorities to protect adjacent and on-site persons, property, buildings, and utilities.
- E. Demolition and removal of all existing site structures, limits as shown on the drawings, including but not limited to all structures (ie. shed), fencing, gates, walls, stairways, railings, and free-standing items (e.g. bollards, signs, sign posts, light poles, light pole bases, canopies, etc.) whether noted or not on the drawings.
- F. Stripping/milling asphalt, if necessary, from areas that are to be incorporated into limits of project and where so indicated on Contract Drawings.
- G. Removal of existing sidewalks, drives, curbs, concrete slabs, etc., as shown on the drawings.
- H. Removal/Abandonment of existing above-ground and underground utilities and associated structure, limits as shown on the drawings. It shall be the responsibility of the Contractor to accurately locate all facilities and to determine their extent. If such facilities obstruct the progress of the work and are not indicated to be removed or relocated, they shall be removed or relocated only as directed by the Owner.
- I. Backfill of all utility/sewer excavations and foundation hollows with structural, compacted fill (as stated in Section 31 00 00 of these specifications).
- J. Installation and maintenance of soil erosion and sediment control measures in accordance with Section 31 25 00 of these specifications.
- K. Removal from site and disposal of all excess and unusable material.
- L. Crushing and stockpiling of concrete and asphaltic pavement for reuse on-site.
- M. Restoration of site and building area grades to that indicated on the final grading plan.

#### **1.2 RELATED SECTIONS AND DOCUMENTS**

- A. Section 020187 – Protection of Existing Utilities
- B. Section 310000 – Earthwork For Sitework
- C. Section 312333 – Soil Erosion and Sediment Control
- D. Local governing authority and code requirements.
- E. Contract Documents

### **1.3 REFERENCE STANDARDS**

- A. New Jersey Soil Erosion and Sediment Control (SESC) Manual
- B. SESC Project Permit and Conditions
- C. All applicable OSHA requirements and other Federal, State, and local codes, laws, ordinances, regulations, and guidelines for demolition and related work.

### **1.4 QUALITY ASSURANCE**

- A. A qualified Engineer shall be retained to perform observation for the duration of the site demolition and earthwork operations to ensure compliance with this Section.
- B. The Engineer shall prepare field reports documenting the progress of the demolition and earthwork operations and submit said reports to the Owner on a weekly basis.
- C. The Owner reserves the right to direct any inspection that is deemed necessary. The Contractor shall provide free access to the site for observation activities.
- D. The Contractor shall provide and maintain a capable and experienced field person representing the Contractor to oversee all demolition and earthwork operations. The representative shall be on site during all operating hours of the project.
- E. The Contractor shall obtain and pay for any permits, bonds, licenses, etc., required for demolition work.
- F. The Contractor shall conduct any work within street or highway right-of-ways in accordance with the requirements of the governmental agencies having jurisdiction and shall not begin until these governing authorities have been notified. The Contractor shall restore to their present conditions any public right-of-way that is disturbed by the work under this section. All pavement restoration work in public rights-of-way shall be performed to the proper satisfaction of the governmental agencies having jurisdiction.

### **1.5 SUBMITTALS**

- A. Prior to the commencement of work, the Contractor shall submit to the Owner record copies of all required permits and certificates obtained for the work in this section. The Contractor shall incur all fees and other requirements associated with obtaining the required permits and certificates.
- B. The Contractor shall submit to the Owner, the Engineer, and all affected utility/service companies, a proposed schedule of coordination for all necessary utility/service shut-offs, capping and continuation of utility services as required no later than 10 days after his notice to proceed. The Contractor shall provide the Owner with written confirmation from all utility or service companies serving the site that service has been terminated prior to capping, abandoning or removal of any such utility and prior to commencement of building demolition.
- C. The Contractor shall submit for review and approval a detailed schedule for all proposed work to the Owner and the Engineer no later than 10 days after notice to proceed. This submission shall include a calendarized schedule of the proposed work and a step-by-step description of all aspects pertaining to demolition and protection of existing structures and adjacent community, labor forces, demolition rubble management and disposal and other items of work required under this Contract. No explosives are permitted.
- D. The Contractor shall submit for approval 15 days prior to the start of demolition work phasing plans that addresses traffic control to the Owner.

## **1.6 ENVIRONMENTAL REQUIREMENTS**

- A. Construct temporary erosion control systems as shown on Contract Drawings to protect adjacent properties and water resources from erosion and sedimentation.
- B. Contractor will be provided with the Soil Erosion and Sediment Control (SESC) permit governing the discharge of stormwater from the construction Site.
- C. Contractor shall be totally responsible for conducting soil erosion and sediment control and the storm water management practices in accordance with SESC permit and for enforcement action taken or imposed by Federal or State agencies, including cost of fines, construction delays, and remedial actions resulting from Contractor's failure to comply with all provisions of the SESC permit.
- D. All work shall be in accordance with any environmental requirements established for the Site.
- E. The Contractor shall ensure that trucks leaving the site shall do so in such a manner that mud and earth will not be deposited on adjacent street pavements. Any mud or earth deposited on street pavements shall be promptly removed by the Contractor.

## **1.7 PROJECT CONDITIONS**

- A. Conditions existing and described by Owner at time of inspection for bidding purposes will be maintained by Owner in so far as practical.
- B. Variations to conditions or discrepancy in actual or described as proposed conditions as they apply to Site preparation operations are to be brought to attention of Owner prior to commencement of sitework.

## **PART 2 - PRODUCTS**

Off-site materials shall be transported to project using well maintained and operating vehicles. Once on Site, transporting vehicles shall stay on designated haul roads and shall at no time endanger improvements by rutting, overloading, or pumping.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. The Contractor is responsible for the demolition of existing structures (ie. shed), concrete slabs, retaining walls, walks and curb, asphalt pavement, utilities, signs and miscellaneous items encountered. Concrete elements encountered after building demolition can be crushed. All asphalt pavement can be milled for reuse as pavement subbase in accordance with geotechnical requirements. All materials that cannot be recycled for reuse on-site shall be disposed off-site in accordance with all applicable Federal, State, County and Local codes and regulation governing legal transportation and disposal of work.
- B. The Contractor shall include for all demolition work necessary to accomplish the construction project.
- C. All work shall be performed as to not adversely impact the neighboring structures, existing utilities, and roadways. Protection of these elements shall be provided as necessary during the course of all construction activities at the site.
- D. Locate and identify existing utilities that are to remain and protect from damage.

- E. Conduct operations with minimum interference to public or private accesses and facilities. Maintain ingress and egress at all times and clean or sweep roadways daily as required by the governing authority.
- F. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by a licensed land surveyor and replaced, as necessary, by same at Contractor's cost.

### **3.2 SITE VISIT**

- A. The Contractor shall visit the site and verify the location of all pertinent items prior to submitting a bid so that the difficulties associated with execution of the contract are fully understood. No additional compensation will be allowed for failure to be so informed.

### **3.3 SOIL EROSION AND SEDIMENT CONTROL**

#### **A. General**

1. Contractor shall install all soil erosion and sediment control measures in accordance with the requirements indicated on the Contract Drawings. All work shall be performed in accordance with the requirements of the New Jersey State Standards & Specifications for Soil Erosion and Sediment Control, latest revision.
2. The Contractor shall be responsible for maintenance of all soil erosion and sediment control measures during the Contract.
3. The Contractor shall keep all streets clear of dirt and sediment and shall be responsible for any cleaning of the streets necessary during the course of the project.
4. Contractor shall, if necessary, obtain approval from and comply with all additional directives issued by the Bergen County Soil Conservation District.

#### **B. Sequence of Construction**

1. The Contractor shall submit written notification to the applicable Soil Conservation District or local authority at least 72 hours prior to the start of construction of any soil erosion and sediment control measures.
2. A temporary crushed stone wheel cleaning pad shall be installed at the construction entrance/exits as shown on the Contract Drawings.
3. Filter fabric silt fence shall be installed and maintained at locations shown on the Contract Drawings.
4. All soil erosion and sediment control measures shall be maintained until all work under this Contract is completed.
5. Contractor shall, as necessary, notify the Somerset-Union Soil Conservation District upon commencement and completion of the project.

### **3.4 TRAFFIC**

- A. Prior to commencement of demolition operations, the Contractor shall implement all vehicular and/or pedestrian traffic protection measures indicated or described on the Contract Drawings and in these Specifications and any other measures required by the Owner, during, and after the demolition project.
- B. The Contractor shall conduct demolition operations and removal of debris in a manner that ensures the least interference with streets, pedestrian walkways, and other adjacent occupied facilities. The Contractor shall prepare and obtain approval by the Owner for a traffic control plan for all aspects of the project.
- C. Signs required shall be designed and installed in accordance with the requirements of the Manual of Uniform Traffic Control Devices and New Jersey Department of Transportation and as indicated on the Contract Drawings.

- D. Maintain vehicular access to adjacent tenants and tenant parking lots and service areas during demolition activities. Temporary access closures should be coordinated with adjacent tenants.

### 3.5 UTILITIES

#### A. General

1. Existing utilities service shall not be interrupted unless authorized in writing by authorities having jurisdiction and the owner of the utility. Any temporary interruption necessary shall be directly coordinated and supervised by utility company personnel. The Contractor shall provide temporary services during interruptions to existing utilities, as acceptable to governing authorities and the affected utility companies.
2. The Contractor shall, during his work, accurately locate and mark on a set of Contract Drawings the location of all underground utilities and services that have been capped and those that are to remain within the Contract Limit Area.

#### B. Maintenance

1. The Contractor shall maintain and protect from damage all existing above and below ground utilities that are to remain. Other utilities to remain include, but are not necessarily limited to, above ground utility lines and transformers within the public right-of-ways. The Contractor shall immediately repair or have repaired by the appropriate utility company any damage incurred by utilities during demolition work at no cost to the Owner or municipality. The Contractor shall be responsible for notifying and coordinating with the appropriate utility companies the shut-off of utilities that are to be abandoned as part of this Contract.

#### C. Abandonment/Removal

1. Prior to removal, all utilities and sewers shall be properly purged and evacuated of all residual gases, oils, etc. or de-energized in the case of electric, telephone or other communications services. All purging and testing shall be approved by local utility or sewer companies and governing authorities having jurisdiction.
2. Existing utilities designated for removal/abandonment shall be completely removed within proposed building footprints.
3. Existing utilities designated for removal/abandonment outside of proposed building footprints can be either completely removed or abandoned in-place by complete filling with grout or flowable, subject to review and approval by Geotechnical Engineer on a case-by-case basis.
4. The Contractor or appropriate utility or sewer company (if required) shall seal and/or plug the ends of all disconnected utilities where indicated on the plan or, if not indicated, at the Contract limit line with lean concrete, gasketed blank steel seal plates, or other measures as recommended and required by the utility or sewer company or Engineer. All plugs shall be inspected by the Engineer and appropriate utility or sewer company prior to backfilling.
5. All utility disconnections shall be performed no later than 15 days prior to the scheduled start of demolition and must precede the demolition permit application procedure.

#### D. Restoration

1. All underground utility lateral removals shall be properly backfilled and all disturbed pavements within the public right-of-way shall be restored to their pre-demolition (existing) condition. This includes the restoration of concrete pavement, concrete curbing, sidewalk and asphalt pavement within the public right-of-way. All pavement and curbing shall be saw cut prior to excavation in order to produce a clean and neat edge. Replacement pavement and curbing shall be equal in design performance to the existing

condition and as directed by the Engineer and/or the local authority having jurisdiction. All restoration work shall be performed immediately following utility removal and backfill completion.

### **3.6 DEMOLITION**

#### **A. General**

1. The Contractor shall also, as part of the requirements of this work, demolish, remove and dispose of all site structures, including all fencing, gates, stairways, ramps, railings, concrete and bituminous pavements, curbs, walls (except those noted to remain) and free standing items (e.g. bollards, signs, sign posts, lighting poles, lighting pole bases, canopies, etc.) within the contract limits unless otherwise indicated on the Contract Drawings.
2. Concrete shall be crushed and reused on site wherever possible. Crushing and recycling of concrete shall be done in accordance with Section 31 00 00 – Earthwork.
3. The Contractor shall backfill all voids/excavations remaining from the removal of foundations and other subsurface elements in accordance with Section 31 00 00 – Earthwork.

#### **B. Cleaning**

1. The Contractor shall maintain the cleanliness of streets and properties of dirt, dust and debris produced by demolition operations at all times. This shall be done on a daily basis. After demolition and debris removal is complete, the Contractor shall return adjacent structures and roadways to the conditions existing prior to the start of work. Power washing or other means deemed necessary by the Owner and/or Engineer shall be implemented by the Contractor to achieve this objective. All cleaning operations to be in accordance with the New Jersey State Standards & Specifications for Soil Erosion and Sediment Control, latest revision.
2. The Contractor shall provide enough refuse containers for collecting construction/demolition debris throughout the duration of all work.

#### **C. Noise**

1. The Contractor shall make all attempts necessary to reduce noise emissions from the site during demolition operations. Noise levels shall be maintained at or below State Standards and/or as required herein. All machinery and equipment shall have mufflers or noise reducing devices installed.



### **3.7 DISPOSAL OF DEMOLISHED MATERIALS**

#### **A. General**

1. The Contractor shall remove from the site all debris, rubbish and other materials resulting from demolition and shall safely and legally dispose of all these items in accordance with applicable Federal, State and local codes and regulations.
2. Recycling of demolition debris is strongly encouraged. All recycling must be done in accordance with all currently applicable State waste flow regulations, County and City requirements.
3. Burning of any demolished materials on-site shall not be permitted.

#### **B. Removal**

1. The Contractor shall legally and safely transport and dispose off-site all demolished materials in accordance with local, State and Federal regulations governing such operations.
2. The Contractor shall be responsible for locating and making arrangements for the safe, legal disposal of demolition material off-site during the entire course of the Contract.

### **END OF SECTION 31 10 00**

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## **SECTION 31 22 00 - EARTHWORK**

### **PART 1 - GENERAL**

#### **1.1 GENERAL REQUIREMENTS**

- A. Work as described in this section, as shown, specified, or required shall be in accordance with the requirements of the Contract Documents and the International Building Code New Jersey Edition (latest edition).

#### **1.2 SCOPE OF WORK**

- A. All excavations (soil and rock), preparations and improvements required to provide satisfactory subgrades and to construct pavements, walls, pits, below grade structures, manholes, areaways, utilities and landscaping as required and indicated on drawings or to a lower elevation to achieve required bearing.
- B. Proof rolling, filling and grading to required lines, dimensions, contours and elevations for proposed improvements.
- C. Scarifying, compaction, moisture content control and removal of unsuitable material to ensure proper preparation of areas for the proposed improvements.
- D. Stabilization of soils cuts and rock cuts including, but not limited to, shoring and bracing, anchors, rock bolts and steel netting, if required.
- E. Monitoring of adjacent structures and roadways during construction.
- F. Placement of lean concrete, compacted structural fill and stone/gravel.
- G. Pumping and dewatering as required for work in this section and for foundation work.
- H. Other labor and materials as may be reasonably inferred to be required to make the work under this Section complete.
- I. Requirements of the construction contract.
- J. Placement of drainage fill/ bedding layer and drainage pipes under building slabs on grade and elsewhere as indicated.
- K. Processing of on-site materials for reuse.
- L. Performing soil testing and inspection services.

#### **1.3 RELATED SECTIONS AND DOCUMENTS**

- A. Architectural and structural plans and specifications as they relate specifically to site work construction, where the architectural and structural requirements are more stringent than the civil requirements.
- B. Contract Documents.
- C. In case of conflict the most stringent shall apply, at no cost to the Owner.

#### **1.4 PROJECT CONDITIONS**

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

#### **1.5 STANDARDS AND REFERENCES**

- A. D 422 Method for Particle Size Analysis of Soils
- B. D 1557 Test for Moisture-Density Relations of Soils Using 10-lb (4.5 Kg) Hammer and 18- inch (457 mm) Drop (Modified Proctor)
- C. D 2216 Laboratory Determination of Moisture content of Soil D 2487 Classification of Soils for Engineering Purposes
- D. D 2922 Tests for Density of Soil and Soil- Aggregate in Place by Nuclear Methods (Shallow Depth)
- E. D 3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
- F. D 4318 Test for Plastic Limit, Liquid Limit, and Plasticity Index of Soils
- G. D 6938 Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)
- H. International Building Code New Jersey Edition (latest edition)
- I. The latest New Jersey Department of Environmental Protection (NJDEP) Regulations.
- J. OSHA Regulations - 29 CFR 1926 Subpart P
- K. In case of conflict, the most stringent shall apply.

#### **1.6 DEFINITIONS**

- A. Wherever the word "excavating", "excavate", "excavation", "carried down", "remove", etc., are used, they shall be taken to include the removal of all materials and any obstructions encountered. Excavation is considered unclassified.
- B. Where the words "finished grades", "finished grade lines", or "future finished grades", appear in these specifications, they shall be taken to mean the finished elevations as indicated on the drawings.
- C. Rough grading consists of cutting or filling to the elevation herein established with a permissible tolerance of plus or minus 1 inch. This tolerance shall be so used within any area of 100 square feet that it will not be necessary to remove excess or bring in additional fill to meet the required elevations.

#### **1.7 QUALITY ASSURANCE**

- A. The Contractor shall provide at least one supervisory person who shall be present at all times during execution of the work and who is thoroughly familiar with the type of work being performed and its best methods for completion. This person shall have the authority to act on behalf of the Contractor.

- B. The Contractor shall comply with any provisions of all applicable codes, regulations and standards.
- C. A Geotechnical Engineer selected and paid by the Owner shall be retained to perform construction inspection on site based on density testing, visual observation, and judgment. This inspection will not relieve the contractor from his responsibility to complete the work in accordance with the plans and specifications.
- D. Visual field confirmation foundation subgrade (rock) and density testing of subgrade preparation and fill placement procedures shall be performed by the field Geotechnical Engineer as part of the construction testing requirements.
- E. The Geotechnical Engineer shall prepare field reports that indicate compaction test location, elevation data, testing results and acceptability. The Owner, Architect, and Contractor shall be provided with copies of reports within 14 days of time test was performed.
- F. All costs related to re-inspection due to failures shall be paid for by the contractor at no additional expense to Owner. The Owner reserves the right to direct any inspection that is deemed necessary. Contractor shall provide free access to site for inspection activities.
- G. Quality assurance testing shall be in accordance with Part 3 of this Section.

## **1.8 SUBMITTALS**

- A. Submit all required submittals including, but not limited to, samples, calculations, reports and shop drawings at least 4 weeks prior to start of work unless specified otherwise. Shop drawings and calculations shall be signed and sealed by a professional engineer licensed in the State of New Jersey. Laboratory tests results shall be certified by an approved testing laboratory. Reports shall be signed by qualified professionals registered in the State of New Jersey.
- B. Samples:
  - 1. The Contractor shall submit a 40 lb representative sample of the proposed off-site fill materials (backfill, drainage fill etc.) to the Civil and Geotechnical Engineers for review and approval.
  - 2. The Contractor shall submit a 12 inch by 12 inch sample of geotextile fabric sample for review and approval, if applicable.
  - 3. The Contractor shall submit a 12-inch-long drainage pipe sample for review and approval, if applicable.
- C. Test Reports:
  - 1. Submit the test reports for each source of each fill material submitted for review and approval by the Geotechnical Engineer. Test reports shall include the results of the following tests:
    - a. Soil classification in accordance with ASTM D 2487
    - b. Moisture content in accordance with ASTM D 2216
    - c. Modified Compaction Test in accordance with ASTM D 1557.
    - d. Particle size analysis in accordance with ASTM D 422 (sieve only)
    - e. Plasticity index in accordance with ASTM D 4318
  - 2. Submit the name of each material supplier and specific type and source of each material. Any change in source or soil type throughout the job requires approval of the Construction Manager and the Engineer. Submit certifications and test results for proposed materials as described below.
- D. Certification:
  - 1. Imported fill shall be free of all hazardous substances as listed by the New Jersey Department of Environmental Protection in New Jersey Administrative Code, Title 7; Chapter 1E, Appendix A. Contractor shall submit certification of compliance and test

- results substantiating compliance to the Construction Manager and Geotechnical Engineer by the Contractor not less than 2 weeks prior to its intended use.
2. Before proceeding with work, Contractor shall submit a certification in an acceptable form, stating that careful examination has been made of the site, existing structures, existing adjacent structures, records of utility lines, test boring records, soil samples, subsurface exploration reports, the drawings, and all other contract documents.
- E. Catalog Cuts:
1. Submit catalog cuts and manufacturer's literature for the equipment to be used for compaction and proofrolling. Static drum weight shall be provided for the proofrolling equipment.
- F. Shop Drawings (As required):
1. The Contractor shall submit a shop drawing showing the procedures, layout and the limits of the proposed excavation for review by the Geotechnical Engineer.
  2. The Contractor shall submit drawings and calculations for his proposed temporary excavation support system and construction dewatering system for review by the Geotechnical Engineer if necessary. Submittals shall be prepared, signed and sealed by a professional engineer licensed in the State of New Jersey.

### **1.9 PROJECT CONDITIONS**

- A. The project site is The Potter Library on the Ramapo College Campus in Mahwah, New Jersey. The proposed development consists of the construction of an expansion to the existing building.
- B. Contractor shall visit the site, read geotechnical engineering reports and shall familiarize himself with the existing project conditions prior to bidding.
- C. Subsurface conditions reported in the geotechnical engineering reports are not intended as representations or warranties of accuracy or continuity between soil borings or test pits. It is expressly understood that the Owner will not be responsible for interpretations or conclusions drawn therefrom by Contractor. Data are made available for convenience of Contractor. Additional test borings and other exploratory operations may be made by Contractor at no cost to the Owner.
- D. Owner shall not accept any claim for variable subsurface conditions, or conditions different than reported in the geotechnical engineering report. If different conditions were observed during construction, they shall be brought to the attention of the Geotechnical Engineer so that those variations can be evaluated.

### **1.10 ERRORS IN DEPTH**

- A. In the event that any part of the excavation be carried, through error, beyond the depth and the dimensions indicated on the drawings or called for in the specifications, then the Contractor, at own expense, shall furnish and install gravel or stone with which to fill to the required level, in all locations except beneath footings.

### **1.11 ENVIRONMENTAL CONSIDERATIONS**

- A. Install erosion control measures in the sequence shown on the Contract Drawings or as directed by the Engineer or regulatory agencies to protect adjacent properties and water resources from erosion and sediment damage.
- B. Certification that imported fill materials are free of all contaminants above non-restricted use standards, as defined by NJDEP, will be required.

- C. Site soils and water may be contaminated. Contractor shall read the environmental assessment reports and shall familiarize himself with the existing environmental conditions. Environmental issues shall be handled in accordance with local codes, standards and AHJ.
- D. Excess materials (soil and/or geotechnically unsuitable materials) that are not re-used on site shall be disposed of in accordance with all applicable regulations. All fees associated with this activity (e.g. sorting co-mingled materials, load-out, transportation, disposal sampling, permits, etc.) are the responsibility of the Contractor. However, activities must be coordinated with the Construction Manager.
- E. Pumping groundwater off the site shall be in accordance with the applicable local and federal regulations. Contractor shall obtain necessary permits to pump the water off the site if necessary.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP and SM, or a combination of these group symbols; free of rock or gravel larger than 3 inches (50 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: ASTM D 2487 Soil Classification Groups GC, SC, ML, MH, CL, OL, OH, and PR, or a combination of these group symbols
- D. Backfill and Fill: Satisfactory soil materials.
- E. Subbase: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2- inch (38-mm) sieve and not more than 12 percent passing a No. 200 (0.075-mm) sieve.
- F. Base: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch (38-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
- G. Bedding: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.
- H. Drainage Fill: Washed, narrowly graded mixture of crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2- inch (38-mm) sieve and 0 to 5 percent passing a No. 8 (2.36-mm) sieve.
- I. Detectable Warning Tape: Polyethylene film warning tape encasing a metallic core, minimum 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility. Retain "Air-Barrier and Water-Resistant Glass-Mat Gypsum Sheathing Performance" Paragraph below if retaining air-barrier and water-resistant glass-mat gypsum sheathing in Part 2.

### **2.2 EQUIPMENT**

- A. Transport off-site materials to project using well-maintained and operating vehicles. Once on site, transporting vehicles shall stay on designated haul roads and shall at no time endanger improvements by rutting, overloading, or pumping.

- B. Proofrolling Compactor: Proofrolling vibratory compactor shall have a static drum weight of at least 5 tons. For cohesive soils use sheepsfoot or padded surface compactors.
- C. Compactor: A vibratory plate or a double drum walk behind roller having a static weight not less than 1 tons for areas where access or maneuverability is limited.
- D. Lightweight construction equipment for grading proposed lawn areas.
- E. All equipment and tools required to perform the work. All equipment and tools shall be in perfect operating conditions.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Prior to all work of this section, the Contractor shall become thoroughly familiar with the geotechnical engineering study as well as the site, site conditions, and all portions of the work falling within this section.
- B. The Contractor shall refer to the soil erosion and sediment control plans for staging of earthwork operations and for erosion control measures to be implemented prior to commencement of earthwork.
- C. Locate and identify existing utilities that are to remain and protect them from damage. Notify utility companies to allow removal and/or relocation of any utilities that are in conflict with the proposed improvements.
- D. Protect fences, structures, sidewalks, paving, curbs, etc to remain from equipment and vehicular traffic.
- E. Protect benchmarks, property corners and all other survey monuments from damage or displacement. If a marker needs to be removed/relocated it shall be referenced by a licensed land surveyor and replaced, as necessary, by the same at no additional cost to the Owner.
- F. Remove from the site, material encountered in earthwork and grading operations that, in opinion of the Owner or Engineer, is unsuitable or undesirable for backfilling in subgrade or foundation areas as per Part 2 of these specifications.

### **3.2 PROTECTION OF EXISTING ADJACENT STRUCTURES, UTILITIES AND ROADWAYS**

- A. Construction activities such as excavation, rock blasting, line drilling and rock chipping with hydraulic hammers may affect the surrounding structures, if not adequately protected and monitored during construction.
- B. The work area is adjacent to the existing buildings, structures and utilities to remain. The Contractor shall be responsible for repairing all construction related damages to the satisfaction of the damaged property owners at Contractor's expense.
- C. The work shall be executed so that no damage or injury will occur to the existing public, adjoining, adjacent structures, streets or utilities. Should any damage or injury caused by the Contractor or anyone in Contractor's employ or by work under this Contract occur, the Contractor shall, at own expense, repair such damage and shall assume all responsibility for such injury and damage.
- D. Excavation sides and adjacent structures, foundations, streets and utilities shall be protected by means of adequate bracing, shoring and sloping, at all times. No excavation shall be carried below adjacent existing foundations or utilities unless adequate measures designed by a Professional Engineer are taken to protect adjacent structures and utilities.

- E. Obtain all required permits and perform all construction work in a safe manner in accordance with applicable codes, regulations and codes.

### **3.3 GENERAL**

- A. Identify required lines, levels, contours and datum to bring site grades to the proposed subgrade conditions inferred from the drawings.
- B. Do not allow or cause any of the work performed or installed to be covered by work of this section prior to all inspections, tests and approvals.
- C. By submitting his bid, the Contractor represents that he has reviewed the information provided and investigated the site to determine type, quantity, quality, and character of excavation work to be performed. All excavation shall be considered unclassified excavation. Excavation shall be performed in a safe manner in accordance with the applicable regulations. Shoring, bracing shall be used where necessary.
- D. The materials excavated shall be separated during excavation. Unsuitable materials shall be defined as any fill having an excess of wood, metal, other objectionable material, saturated fill material and organic soil. The Geotechnical Engineer shall determine which soils are unsuitable. This material shall be removed and disposed of off-site legally at no cost to the Owner. Excavated rock materials shall be crushed for reuse on-site as needed.
- E. Suitable excavated material as directed by the Geotechnical Engineer shall be stockpiled on site for later reuse. This material consists of materials which may be susceptible to increases in moisture. The Contractor shall maintain the optimum field moisture content of this material via implementing positive drainage and covering the stockpiles.
- F. Graded areas outside the building area shall be excavated/filled to within 4 inches of final grades in landscaped areas and to within 0.1 foot of final subgrade within paved areas as shown on the plans.
- G. Perform excavation using capable, well maintained equipment and methods acceptable to the owner and governing agencies.
- H. When performing grading operations during periods of prolonged wet or dry weather, provide adequate measures for surface drainage and ground water control, and moisture control of soils (i.e., wetting or drying by discing) so as to place and compact the soil within the moisture content range a few percentage points of its optimum water content. Any disturbed areas should be proofrolled at the end of each day.
- I. Shoring, bracing, and fencing shall be installed in accordance with Federal OSHA requirements as well as the requirements of all state and local authorities having jurisdiction. Shoring and bracing shall also be performed in accordance with Bracing and Shoring section below.
- J. Protect persons and property from damage and discomfort caused by dust. Water as necessary to quell dust. Contractor shall ensure that no sidewalks and roadways will have any issue with icing when water spraying is used during freezing temperatures.
- K. All underground installation of pipes, conduit, structures etc. in the area to be paved shall be completed prior to placement of any asphalt or concrete paving.
- L. Allow no debris to accumulate on-site. Haul debris away from the site and dispose of at no cost to the Owner.
- M. Excess on-site soils shall be disposed of off-site in accordance with the applicable regulations at no cost to the Owner.



- N. Contaminated on-site soils, if any, shall be disposed of off-site in accordance with the applicable regulations at no cost to the Owner.

### **3.4 DEMOLITION OF EXISTING STRUCTURES**

- A. Completely demolish and remove any existing buried structure (e.g. old foundations, slabs, walls, tanks, utilities) from below the proposed building foundations. Remove any buried abandoned structure at least 3 feet below the proposed slab or building foundation.

### **3.5 STORAGE OF SOIL MATERIALS**

- A. Stockpile excavated materials acceptable for backfill and fill soil materials, including acceptable borrow materials. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent wind-blown dust and to prevent moisture susceptible soils from becoming saturated, and therefore, unsuitable for reuse. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

### **3.6 PAVEMENT AND PAD SUBGRADE PREPARATION**

- A. Pavement and pad subgrades shall be accomplished as follows:
  1. Pavement shall bear on improved existing fill, natural soils or rock, or imported structural fill. Subgrades shall be inspected by a qualified Geotechnical Engineer.
  2. Remove all surficial material (topsoil, asphalt, etc.) and proofroll the exposed subgrade (soil subgrades only) that is to receive pavements in accordance with the requirements of Proofrolling section given below.
  3. In fill areas, structural fill shall be placed in lifts over the proofrolled subgrade and shall be compacted. The fill materials gradation shall meet the requirements given in Part 2 of these specifications. Placement and compaction of fill shall be in accordance with the requirements given below in the Backfilling and Compaction section.
  4. Protect the subgrades against the effects of weather and equipment. Appropriate surface drainage and protection methods such as trenching, sloping, and pumping should be implemented to maintain the subgrades in a dry and workable condition at all times.

### **3.7 LAWN AREA SUBGRADE PREPARATION**

- A. Lawn area subgrade preparation shall be accomplished as follows:
  1. In fill areas, excavate all topsoil. Excavate natural and/or fill materials down to subgrade elevation and stockpile on-site. The fill materials gradation shall meet the requirements given in Part 2 of these specifications. Placement and compaction of fill shall be in accordance with the requirements given below in the Backfilling and Compaction section.
  2. In cut areas, remove all material to the proposed elevation provided on the Contract Documents.

### **3.8 PROOFROLLING**

- A. The work shall consist of proofrolling of all excavated soil subgrades for slabs, pavements and roadways.
  1. Proofroll the subgrade with a heavy vibratory drum roller having a minimum static weight as specified in Part 2. A minimum of 6 passes shall be carried out over the exposed subgrades.
  2. If any material exhibits instability (i.e. pumping, weaving or rutting) under the action of the roller, the unstable areas should be over-excavated to remove the unstable soil and should be backfilled with compacted clean structural fill. Backfilling and compaction shall be performed in accordance with requirements of Backfilling and Compaction section below.
  3. The Contractor shall establish operating procedures whereby uniform coverage of an area is obtained and the number of passes of the compaction equipment can be readily determined.

### **3.9 BACKFILLING AND COMPACTION**

- A. Backfill excavations promptly, but not before completing the following:
1. Acceptance of construction below finished grade including, where applicable, damp proofing, waterproofing, and perimeter insulation, as specified in Contract Documents.
  2. Surveying locations of underground utilities for record documents.
  3. Testing, inspecting, and approval of underground utilities.
  4. Removing concrete formwork, trash and debris from excavation.
  5. Removing temporary shoring, bracing, and sheeting in accordance with the relevant specifications. Any material left in place to minimize damage to existing utilities to remain shall be cut off at least 2 feet below grade.
  6. Installing permanent or temporary horizontal bracing on horizontally supported walls.
- B. Place and compact the fill as described below:
1. Suitable on-site and/or imported off-site fill shall be placed and compacted as required within site improvement areas. Structural fill shall be used in areas to slabs, pavements, utilities and behind below-grade walls. Non-structural fill shall be used only in landscape areas. Drainage fill shall be used where specified in the Contract Documents.
  2. Fill placed between existing subgrade and slabs, pavements and lawn subgrade areas shall be placed in loose lifts not exceeding 12 inches in thickness and should be compacted with a heavy vibratory plate compactor or roller. Correspondingly, thinner loose lifts should be used in areas where smaller compaction equipment must be utilized due to restricted access.
  3. No fill shall be placed in standing water. Any seepage or ponding of water shall be pumped from the excavation prior to placement of fill. No fill shall be placed on frozen ground.
  4. Each lift of fill placed for foundation, building slab and pavement support, shall be compacted to a minimum dry density equal to 95% of the maximum dry density as determined by ASTM D1557 (Modified Proctor Test). If the water content of the fill is such that proper compaction cannot be achieved, water shall be added or the soil dried in order to obtain a water content at which the required compaction can be achieved. Fill placed for lawn area subgrade shall be compacted to 90% of the maximum dry density.
  5. The Contractor shall establish operating procedures whereby uniform coverage of an area is achieved and the number of passes of the compaction equipment can be readily determined. At the completion of the day's work, the fill surface shall be sealed with the roller.
  6. No frozen material shall be used as fill. If the fill material which has been compacted, tested and approved by the Engineer becomes frozen, the Engineer shall be notified and shall determine whether it can remain in place or shall be removed before additional fill can be placed.
  7. During rainy weather, the contractor shall take measures to protect fill from becoming saturated. The Contractor shall not place or attempt to compact fill during rainy weather unless approved by the Geotechnical Engineer. Any water collecting in fill areas shall be removed before further fill placement.
  8. After fill work has been completed in a pavement area, the area shall be graded smooth to within 0.1 ft of the final subgrade elevations shown on the Contract Drawings and shall be proofrolled as specified herein.

### **3.10 SHORING AND BRACING**

- A. The Contractor shall utilize all appropriate methods to shore, brace and stabilize excavations and cuts in accordance with OSHA regulations, Building Code and Contract Documents. In case of conflict, the most stringent shall apply. This work shall also be completed in accordance with shoring specifications also.
- B. Contractor shall supply all necessary equipment, labor to perform the work in a safe manner and to protect labor, adjacent structures, utilities, streets and people.

- C. Bench, step and slope excavations in accordance with OSHA regulations. Use rakers, soldier piles, lagging, trench box, etc to support the cuts, where necessary. Implement of all required safety measures to prevent damage to adjacent structures and public.
- D. All temporary excavation support systems shall be designed by a Professional Engineer retained by the Contractor. Submit temporary support calculations and drawings for review by the Engineer.
- E. Excavation sides and adjacent structures, foundations, streets shall be protected by means of adequate bracing, shoring, sloping at all times.

### **3.11 DEWATERING**

- A. The excavations are anticipated to be above the observed groundwater levels but cuts in impervious strata (glacial soils and rock) will collect surficial water seeping down or traveling over the impervious layers.
- B. The Contractor shall utilize appropriate dewatering equipment, tools, gravel sumps and pumps as necessary to remove groundwater, perched water and accumulated water in excavated areas, utility trenches and other excavations until such time that backfilling and the relevant construction is complete.
- C. Contractor shall supply all necessary equipment and labor including but not limited to wells, pumps and crushed stone.
- D. Water collected in fill areas shall be removed by conventional sumps and pumps before any fill is placed.
- E. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding project site and surrounding area. Protect subgrades from softening and damage by rain or water accumulation.
- F. No concrete, formwork, pipe, or bedding shall be placed in water unless specific approval is obtained from the Engineer.
- G. Water removed from an excavation shall be disposed of in such a manner as to avoid interference with vehicular or pedestrian traffic and to prevent damage to adjacent property or construction. All pumping and discharging shall be performed in accordance with local and federal regulations. Contractor shall obtain the required permits and approvals for groundwater discharge from the authorities having jurisdiction. Discharging directly into manholes or existing pipes will not be permitted unless approved by the appropriate local authority and the Owner. It shall be the Contractor's responsibility to discharge the water in such a manner that mud and silt are not discharged into the existing system, to remove from such facilities any mud, silt, and debris which has accumulated and to leave the drainage facility in a condition similar to that which existed prior to his operations.

### **3.12 MAINTENANCE AND PROTECTION**

- A. Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- B. Repair and re-establish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or lose compaction due to subsequent construction operations or weather conditions. Scarify or remove and replace material to depth directed by the Engineer; reshape and recompact at optimum moisture content to the required density.
- C. Where settling occurs during the project correction period, remove finished surfacing, backfill with additional approved material, compact, and reconstruct surfacing. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of

restoration. Appropriate surface drainage and protection methods such as trenching, sloping, and pumping shall be implemented to maintain the subgrades in a dry and workable condition.

### **3.13 ENVIRONMENTAL ISSUES**

- A. Contractor shall handle the contaminated soils, if any, in accordance with the requirements applicable contract documents and regulations.

### **3.14 FIELD QUALITY CONTROL**

- A. Owner's Responsibilities:
  - 1. Owner shall hire an independent testing agency and a qualified geotechnical engineer to inspect the earthwork.
  - 2. Independent testing agency shall perform field in-place density tests where required, using a nuclear densometer in accordance with ASTM D 2922.
- B. Contractor's Responsibilities:
  - 1. Contractor shall retain a professional engineer who shall design and inspect dewatering, excavation support systems, excavation procedures, rock excavation procedures, shoring, bracing, stabilization as necessary.
  - 2. Contractor shall be also responsible for retaining qualified professional engineers, certified testing agencies and licensed surveyors to perform required inspections and monitoring not covered by the Owner.

**END OF SECTION 31 22 00**

## **SECTION 31 23 33 - TRENCH EXCAVATION AND BACKFILL**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

Drawings and general provisions of the Contract, including general and supplementary conditions and specifications in sections apply to this section.

- A. Contract Documents

#### **1.2 SUMMARY**

Work included: The work of this section includes, but is not limited to the following:

- A. Trench excavation shall consist of the removal of all pavement, earth and other materials encountered, required for the construction of utility lines, structures, laterals, and appurtenances as shown on the Contract Drawings.
- B. Work shall consist of the placement and compaction of bedding material, select fill, and general backfill in trench excavations.

#### **1.3 REFERENCES**

- A. American Society for Testing and Materials (ASTM) Latest Edition
  - D 422 Method for Particle Size Analysis
  - D 698 Test of Moisture Density Relations of Soils - Standard Proctor Method
  - D 1557 Test for Moisture-Density Relations of Soils Using 10-lb. (4.5 Kg) Hammer and 18-inch (457 mm) Drop (Modified Proctor)
  - D 2216 Laboratory Determination of Moisture Content of Soil
  - D 2487 Classification of Soils for Engineering Purposes
  - D 2922 Tests for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
  - D 3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
  - D 4318 Test for Plastic Limit, Liquid Limit, & Plasticity Index of Soils
- B. American Association of State Highway and Transportation Officials (AASHTO) latest edition
  - T 88 Mechanical Analysis of Soils

#### **1.4 SUBMITTALS**

- A. Shop Drawings or details pertaining to site utilities are not required unless the use of materials, methods, equipment, or procedures contrary to the Construction Drawings or these specifications are proposed. No work shall be performed until shop drawings, if required, have been accepted by the Owner and Engineer.
- B. The Contractor shall contact all utility companies and identify any requirements. Contractor shall provide written confirmation of the status of all utility construction to the Owner at the time of the preconstruction conference or no later than 30 days following the project possession date.
- C. Submit a sample of each type of offsite fill and/or bedding material that is to be used in backfilling.

## 1.5 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations of all subsurface utilities, structures and obstructions encountered.
- B. Accurately record any as-built variation from the construction plans and specifications. The Contractor shall provide as-built drawings within 30 days of project completion.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Bedding Material: AASHTO No. 67 processed sand and gravel free from debris, clay lumps, organic, or other deleterious material, and complying with following gradation requirements:

<u>U. S. Sieve Size</u>	<u>Percent Passing (by weight)</u>
1 inch	100
3/4 inch	90-100
3/8 inch	20-55
No. 4	0-10
No. 8	0-5

- B. Backfill material approved by the owner and/or the Engineer.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Set all lines, elevations, and grades for utility and drainage system work and maintain for the duration of work. Provide careful maintenance of benchmarks, property corners, monuments, or other reference points.
- B. Protect and maintain in operating condition, existing utilities encountered during utility installation. Repair any damage to surface or subsurface improvements shown on Drawings.
- C. Verify location, size, elevation, and other pertinent data required to make connections between existing utilities and proposed construction indicated on Drawings. Contractor shall comply with all local codes and regulations.
- D. Over excavate and properly prepare areas of subgrade that are not capable of supporting the proposed systems. These areas are to be stabilized by using acceptable backfill materials and/or additional bedding material placed and compacted as specified in the contract documents.

### 3.2 EXCAVATION

- A. Contact local utility companies before excavation begins. Dig trenches at proper width and depth for laying utility. Cut trench banks for safety and remove stones as necessary to avoid point-bearing.
- B. All trench excavation side walls shall be sloped, shored, sheeted, braced or otherwise supported by means of sufficient strength to protect the workmen within them in accordance with the applicable rules and regulations established for construction by the Department of Labor, Occupational Safety and Health Administration (OSHA), and by local ordinances. Lateral travel distance to an exit ladder or steps shall not be greater than 25 feet in trenches 4 feet or deeper.
- C. Trench width requirements below the top of the pipe shall not be less than 12 inches nor more than 18 inches wider than outside surface of any pipe or conduit that is to be installed. All other

trench width requirements for utility shall be the minimum practical width that will allow for proper compaction of trench backfill and satisfy safety and utility company regulations.

- D. Accurately grade trench bottom to an elevation 6 inches below the pipe, as per bedding details in construction drawings. Provide uniform bearing and support for each section of pipe on bedding material at every point along the entire length, except where necessary to excavate for bell holes, pipe joints, or other required connections. Dig bell holes and depressions for joints after trench bottom has been graded. Dig no deeper, longer, or wider than needed to make the joint connection properly.
- E. During excavation, stockpile excavated material suitable for backfilling in an orderly manner far enough from the trench to avoid overloading, slides, or cave-ins.
- F. Remove excavated materials from the site which are not suitable for backfill.
- G. Any abandoned structures utilities or debris discovered during excavation shall be removed and disposed of, or capped.
- H. Utility alignments have been designed to avoid expected obstructions wherever possible. If unanticipated significant obstructions are encountered during utility installation work immediately notify the Owner and Engineer.
- I. Prevent surface water from flowing into trenches or other excavations by temporary grading or other methods, as required. Remove accumulated water in trenches or other excavations by pumping or other acceptable methods. Water shall not be directly pumped to the municipal sewer system.

### **3.3 PIPE BEDDING**

- A. Accurately cut trenches for pipe or conduit to designated line and grade 6 inches below the bottom of the pipe, to width as specified previously. Compact trench bottoms a minimum of 95% of the maximum dry density as determined by ASTM D1557, Modified Proctor Test.
- B. Over excavate wet or unstable soil, if encountered, from trench bottom as necessary to provide a suitable base for continuous and uniform bedding.
- C. Place bedding material and compact in 6-inch loose lifts to obtain at least 95% of the maximum dry density. Accurately shape bedding material to conform to lower portion of pipe barrel. After pipe installation, place and compact bedding material as specified above in maximum 6-inch loose layers to the springline of the pipe.

### **3.4 BACKFILLING**

- A. After pipe or conduit has been installed, bedded and tested as necessary, backfill trench to finish grade in 8-inch thick loose lifts of approved fill soils, compacting and testing each lift as specified above.
- B. Systematically backfill to allow maximum time for natural settlement. Do not backfill over porous, wet, frozen or spongy subgrade surfaces. Should these conditions exist, the areas should be removed, replaced and recompacted.

### **3.5 COMPACTION**

- A. All off-site materials used for backfill shall be tested.
- B. Exercise proper caution when compacting immediately over top of pipes or conduits.
- C. Maintain optimum moisture content of fill materials to attain required compaction density.

**END OF SECTION 31 23 33**

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## **SECTION 31 25 00 - SOIL EROSION AND SEDIMENT CONTROL**

### **PART 1 - GENERAL**

#### **1.1 SCOPE OF WORK**

- A. Engineer shall provide Soil Erosion and Sediment Control Permit.
- B. Temporary and permanent soil erosion control systems.

#### **1.2 RELATED SECTIONS**

- A. 310000 – Earthwork For Sitework
- B. Contract Drawings

#### **1.3 REFERENCE STANDARDS**

- A. The Standards for Soil Erosion and Sediment Control in New Jersey, latest revision.

#### **1.4 QUALITY ASSURANCE**

- A. The Engineer shall provide the Contractor with a Soil Erosion and Sediment Control Permit from the Bergen County Soil Conservation District.
- B. The Contractor shall notify, in writing, at least 72 hours prior to any soil disturbance as noted on the Contract Drawings, the Bergen County Soil Conservation District.
- C. The Contractor shall carefully adhere to the construction sequence that is shown on the Contract Drawings.
- D. The Contractor shall follow Soil Erosion and Sediment Control Notes that are shown on the Contract Drawings.
- E. The Contractor shall make frequent inspection of temporary soil erosion controls and maintain them in working order until permanent soil erosion controls are established.

#### **1.5 ENVIRONMENTAL REQUIREMENTS**

- A. The Contractor shall protect adjacent properties and water resources from soil erosion and sediment damage throughout construction.
- B. Discharge from dewatering operations shall not be directed to surface waters.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- A. Quick-growing grasses such as wheat, rye or oats in accordance with Contract Drawings.
- B. Fencing for siltation control as specified on the Contract Drawings.
- C. Temporary mulches such as loose hay, straw, netting, cellulose or agricultural silage.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Review site conditions and sediment control plans.
- B. Review the soil erosion and sediment control plans as they apply to current conditions. Any proposed deviation from the plans must be submitted to the Owner's Engineer in writing 72 hours prior to commencing that work.
- C. Notify the Bergen County Soil Conservation District.

### **3.2 SOIL EROSION CONTROL AND SLOPE PROTECTION IMPLEMENTATION**

- A. Place soil erosion control systems in accordance with the Contract Documents prior to any earthwork construction.
- B. Limit the surface area of erodible earth material exposed by clearing and grubbing, excavation, borrow and embankment operations by following the construction phasing on the Soil Erosion and Sediment Control Plan.
- C. The Contractor will be required to incorporate all permanent soil erosion control features into the project at the earliest practical time to minimize the need for temporary controls. Cut slopes shall be permanently seeded and mulched as the excavation proceeds to the extent considered desirable and practical. Equip catch basins with filter fabric inlet protection immediately upon construction.
- D. The temporary soil erosion control systems installed by the Contractor shall be maintained as directed by the Owner's Engineer to control siltation at all times during the life of the contract. The Contractor must respond to any maintenance or additional work ordered by the Owner's Engineer within a 48 hour period.
- E. Slopes that erode easily shall be temporarily seeded as the work progresses with quick growing grass grains of wheat, rye or oats unless otherwise specified in the Landscape Specifications. In areas where seeding is ineffective, the Owner's Engineer or other governing authorities, the Contractor shall provide fibrous netting as shown on Contract Drawings at no additional cost to the Owner.
- F. All soil erosion control measures shall be maintained until all permanent improvements to the site are complete unless otherwise directed by the Owner's Engineer.

### **END OF SECTION 31 25 00**

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## **SECTION 32 12 16 – ASPHALT PAVING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Cold milling of existing asphalt pavement.
  - 2. Hot-mix asphalt patching.
  - 3. Hot-mix asphalt paving.
  - 4. Hot-mix asphalt overlay.
  - 5. Asphalt curbs.
  
- B. Related Requirements:
  - 1. Section 312000 "Earth Moving" for subgrade preparation, fill material, separation geotextiles, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.
  - 2. Section 321373 "Concrete Paving Joint Sealants" for joint sealants and fillers at pavement terminations.

#### **1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  
- B. Sustainable Design Submittals:
  - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.

#### **1.3 INFORMATIONAL SUBMITTALS**

- A. Material Certificates: For each paving material. Include statement that mixes containing recycled materials will perform equal to mixes produced from all new materials.

#### **1.4 QUALITY ASSURANCE**

- A. Installer Qualifications: Engage an experienced installer who has completed hot-mix asphalt paving similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
  
- B. Manufacturer Qualifications: Engage a firm experienced in manufacturing hot-mix asphalt similar to that indicated for this Project and with a record of successful in-service performance.

### **PART 2 - PRODUCTS**

#### **2.1 AGGREGATES**

- A. Coarse Aggregate: ASTM D 692/D 692M, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
  
- B. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
  
- C. Mineral Filler: ASTM D 242/D 242M or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

## **2.2 ASPHALT MATERIALS**

- A. Asphalt Binder: ASTM D 6373 or AASHTO M 320 binder designation PG 64-22 PG 58-28 PG 70-22
- B. Tack Coat: ASTM D 977 or AASHTO M 140 emulsified asphalt, or ASTM D 2397/D 2397M or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

## **2.3 AUXILIARY MATERIALS**

- A. Recycled Materials for Hot-Mix Asphalt Mixes: Reclaimed asphalt pavement; reclaimed, unbound-aggregate base material; and recycled tires, asphalt shingles, or glass from sources and gradations that have performed satisfactorily in previous installations, equal to performance of required hot-mix asphalt paving produced from all new materials.
- B. Herbicide: Commercial chemical for weed control, registered by the EPA, and not classified as "restricted use" for locations and conditions of application. Provide in granular, liquid, or wettable powder form.

## **2.4 MIXES**

- A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2, "Asphalt Mix Design Methods"; and complying with the following requirements:
  - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
  - 2. Base Course: comply with local state DOT
  - 3. Surface Course: comply with local state DOT

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

### **3.2 COLD MILLING**

- A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.
  - 1. Mill to a depth of 2 inches.
  - 2. Patch surface depressions deeper than 1 inch (25 mm) after milling, before wearing course is laid.

### **3.3 PATCHING**

- A. Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
- B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseal concrete pieces firmly.

1. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.
- C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- D. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

### **3.4 SURFACE PREPARATION**

- A. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Herbicide Treatment: Apply herbicide according to manufacturer's recommended rates and written application instructions. Apply to dry, prepared subgrade or surface of compacted-aggregate base before applying paving materials.
- C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

### **3.5 PLACING HOT-MIX ASPHALT**

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
1. Spread mix at a minimum temperature of 250 deg F (121 deg C).
  2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet (3 m) wide unless infill edge strips of a lesser width are required.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

### **3.6 JOINTS**

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
1. Clean contact surfaces and apply tack coat to joints.
  2. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150 mm).
  3. Offset transverse joints, in successive courses, a minimum of 24 inches (600 mm).
  4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

### **3.7 COMPACTION**

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
  - 1. Complete compaction before mix temperature cools to 185 deg F (85 deg C).
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
  - 1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041/D 2041M, but not less than 90 percent or greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

### **3.8 ASPHALT CURBS**

- A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at a minimum temperature of 250 deg F (121 deg C).
  - 1. Asphalt Mix: Same as pavement surface-course mix.
- B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

### **3.9 INSTALLATION TOLERANCES**

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
  - 1. Base Course: Plus or minus 1/2 inch (13 mm).
  - 2. Surface Course: Plus 1/4 inch (6 mm), no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:
  - 1. Base Course: 1/4 inch.
  - 2. Surface Course: 1/8 inch.
  - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).

**3.10 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Replace and compact hot-mix asphalt where core tests were taken.
- C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

**3.11 WASTE HANDLING**

- A. General: Handle asphalt-paving waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

**END OF SECTION 32 12 16**

## **SECTION 32 13 13 – CONCRETE PAVING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes Concrete Paving, including the following:
  - 1. Pads at building egress & benches
  - 2. Walks and stairs
  - 3. Paving at utility area

#### **1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
  - 1. Product Data: For recycled content, indicating postconsumer and preconsumer recycled content and cost.
  - 2. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.
  - 3. Laboratory Test Reports: For concrete paving mixtures, documentation indicating that cured concrete complies with Solar Reflectance Index requirements.
- C. Samples: For each type of product, ingredient, or admixture requiring color selection.
- D. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

#### **1.3 QUALITY ASSURANCE**

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
  - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

#### **1.4 PRECONSTRUCTION TESTING**

- A. Preconstruction Testing Service: Engage a qualified independent testing agency to perform preconstruction testing on concrete paving mixtures.

### **PART 2 - PRODUCTS**

#### **2.1 CONCRETE, GENERAL**

- A. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.

#### **2.2 STEEL REINFORCEMENT**

- A. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, fabricated from as-drawn steel wire into flat sheets.
- B. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, flat sheet.



- C. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.
- D. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars; zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.
- E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

## **2.3 CONCRETE MATERIALS**

- A. Regional Materials: Concrete shall be manufactured within 500 miles (800 km) of Project site from aggregates and cementitious materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.
- B. Regional Materials: Concrete shall be manufactured within 500 miles (800 km) of Project site.
- C. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
  1. Portland Cement: ASTM C 150/C 150M, gray portland cement Type I or Type II.
  2. Fly Ash: ASTM C 618, Class C
  3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
  4. Blended Hydraulic Cement: ASTM C 595/C 595M, Type IS, portland blast-furnace slag or Type IP or portland-pozzolan or Type IL, Portland-limestone or Type IT, ternary blended cement.
- D. Normal-Weight Aggregates: ASTM C 33/C 33M, Class 4S Class 4M uniformly graded. Provide aggregates from a single source.
- E. Air-Entraining Admixture: ASTM C 260/C 260M.
- F. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
- G. Color Pigment: ASTM C 979/C 979M, synthetic mineral-oxide pigments or colored water-reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.
  1. Product: Solomon Colors, Inc; Liquid Color, Dry Integral Color or equivalent
  2. Color: As selected by Landscape Architect from manufacturer's full range
- H. Water: Potable and complying with ASTM C 94/C 94M.

## **2.4 CURING MATERIALS**

- A. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) dry.
- B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- C. Water: Potable.
- D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.
  1. Products:

- a. Axim Concrete Technologies; Cimfilm.
  - b. Burke by Edeco; BurkeFilm.
  - c. ChemMasters; Spray-Film.
  - d. Conspec Marketing & Manufacturing Co., Inc.; Aquafilm.
  - e. Dayton Superior Corporation; Sure Film.
  - f. Euclid Chemical Company (The); Eucobar.
  - g. Kaufman Products, Inc.; Vapor Aid.
  - h. Lambert Corporation; Lambco Skin.
  - i. L&M Construction Chemicals, Inc.; E-Con.
  - j. MBT Protection and Repair, ChemRex Inc.; Confilm.
  - k. Meadows, W. R., Inc.; Sealtight Evapre.
  - l. Metalcrete Industries; Waterhold.
  - m. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
  - n. Sika Corporation, Inc.; SikaFilm.
  - o. Symons Corporation; Finishing Aid.
  - p. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.
- E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.
- 1. Products:
    - a. Anti-Hydro International, Inc.; AH Curing Compound #2 DR WB.
    - b. Burke by Edoko; Aqua Resin Cure.
    - c. ChemMasters; Safe-Cure Clear.
    - d. Conspec Marketing & Manufacturing Co., Inc.; W.B. Resin Cure.
    - e. Dayton Superior Corporation; Day Chem Rez Cure (J-11-W).
    - f. Euclid Chemical Company (The); Kurez DR VOX.
    - g. Kaufman Products, Inc.; Thinfilm 420.
    - h. Lambert Corporation; Aqua Kure-Clear.
    - i. L&M Construction Chemicals, Inc.; L&M Cure R.
    - j. Meadows, W. R., Inc.; 1100 Clear.
    - k. Nox-Crete Products Group, Kinsman Corporation; Resin Cure E.
    - l. Symons Corporation; Resi-Chem Clear.
    - m. Tamms Industries Inc.; Horncure WB 30.
    - n. Unitex; Hydro Cure 309.
    - o. Vexcon Chemicals, Inc.; Certi-Vex Enviocure 100.

## 2.5 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber or ASTM D 1752, cork or self-expanding cork in preformed strips.
- B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

## 2.6 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
- B. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce total amount of portland cement, which would otherwise be used, by not less than 40 percent. Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
  - 1. Fly Ash or Pozzolan: 25 percent.

2. Slag Cement: 50 percent.
  3. Combined Fly Ash or Pozzolan, and Slag Cement: 50 percent, with fly ash or pozzolan not exceeding 25 percent.
- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
1. Air Content: 4-1/2 percent plus or minus 1-1/2 percent.
- D. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
- E. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd. (0.60 kg/cu. m)
- F. Color Pigment: Add color pigment to concrete mixture according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup.
- G. Concrete Mixtures: Normal-weight concrete.
1. Compressive Strength (28 Days): 4000 psi (27.6 MPa)
  2. Maximum W/C Ratio at Point of Placement: [0.45] [0.50] <Insert ratio>.
  3. Slump Limit: 5 inches (125 mm), plus or minus 1 inch (25 mm).
  4. Solar Reflectance Index: Not less than 29.

## **2.7 CONCRETE MIXING**

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

### **3.2 PREPARATION**

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

### **3.3 EDGE FORMS AND SCREED CONSTRUCTION**

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

### **3.4 STEEL REINFORCEMENT INSTALLATION**

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

### **3.5 JOINTS**

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

### **3.6 CONCRETE PLACEMENT**

- A. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- B. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.
- C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- D. Screed paving surface with a straightedge and strike off.
- E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

### **3.7 FLOAT FINISHING**

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
  - 1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
  - 2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.
  - 3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.
- C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions.
  - 1. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
  - 2. After curing, lightly work surface with a steel-wire brush or abrasive stone and water to expose nonslip aggregate.

### **3.8 CONCRETE PROTECTION AND CURING**

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound or a combination of these.

### **3.9 PAVING TOLERANCES**

- A. Comply with tolerances in ACI 117 (ACI 117M) and as follows:
  - 1. Elevation: 3/4 inch (19 mm) general, 1/4 inch at points of egress & landings
  - 2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
  - 3. Surface: Gap below 10-foot- (3-m-) long; unlevelled straightedge not to exceed 1/2 inch (13 mm).
  - 4. Joint Spacing: 3 inches (75 mm).
  - 5. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
  - 6. Joint Width: Plus 1/8 inch (3 mm), no minus.

### **3.10 REPAIR AND PROTECTION**

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

**END OF SECTION 32 13 13**

## **SECTION 32 13 73 – CONCRETE PAVING JOINT SEALANTS**

### **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. Expansion and contraction joints within cement concrete pavement.
  - 2. Joints between cement concrete and asphalt pavement.
- B. Related Sections include the following:
  - 1. Division 32 Section "Asphalt Paving" for constructing joints between concrete and asphalt pavement.
  - 2. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.
  - 3. Division 7 Section "Joint Sealants" for sealing nontraffic and traffic joints in locations not specified in this Section.

#### **1.3 SUBMITTALS**

- A. Submit under provisions of Section 01 3300.
- B. Product Data: For each joint-sealant product indicated.
- C. Samples for Verification: For each type and color of joint sealant required. Install joint-sealant samples 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.
- D. Product Certificates: For each type of joint sealant and accessory, signed by product manufacturer.
- E. Qualification Data: For Installer.
- F. Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
  - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
  - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for sealants.

#### **1.4 QUALITY ASSURANCE**

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit not fewer than eight pieces of each type of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.

D. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing of current sealant products within a 36-month period preceding the Notice to Proceed with the Work.

1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 for testing indicated, as documented according to ASTM E 548.

## **1.5 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials to comply with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

## **1.6 PROJECT CONDITIONS**

- A. Do not proceed with installation of joint sealants under the following conditions:
  1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (4.4 deg C).
  2. When joint substrates are wet or covered with frost.
  3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
  4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

## **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.

### **2.2 MATERIALS, GENERAL**

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.

**Colors of Exposed Joint Sealants: To match Concrete.**

### **2.3 COLD-APPLIED JOINT SEALANTS**

- A. Single-Component, Nonsag, Silicone Joint Sealant for Concrete: ASTM D 5893, Type NS.
  1. [Products](#): Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. [Crafco Inc.](#), an ERGON company; RoadSaver Silicone.
- b. [Dow Corning Corporation](#); 888.
- c. [Pecora Corporation](#); 301 NS.
- d. Or approved equal.

## **2.4 JOINT-SEALANT BACKER MATERIALS**

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
- B. Retain paragraph below for use of cold- and hot-applied sealants in joints, such as contraction joints, where backer materials serve only to limit sealant depth and prevent bottom-side adhesion.
- C. Round Backer Rods for Cold- and Hot-Applied Sealants: ASTM D 5249, Type 1, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.
- D. Backer Strips for Cold- and Hot-Applied Sealants: ASTM D 5249; Type 2; of thickness and width required to control sealant depth, prevent bottom-side adhesion of sealant, and fill remainder of joint opening under sealant.
- E. Round Backer Rods for Cold-Applied Sealants: ASTM D 5249, Type 3, of diameter and density required to control sealant depth and prevent bottom-side adhesion of sealant.

## **2.5 PRIMERS**

- A. Primers: Product 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.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where indicated or 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.

### **3.3 INSTALLATION OF JOINT SEALANTS**

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.



- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install backer materials 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 backer materials.
  - 2. Do not stretch, twist, puncture, or tear backer materials.
  - 3. Remove absorbent backer materials that have become wet before sealant application and replace them with dry materials.
- D. 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 provided for each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. 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 sealants from surfaces adjacent to joint.
  - 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions, unless otherwise indicated.
- G. Provide recessed joint configuration for silicone sealants of recess depth and at locations indicated.

### **3.4 CLEANING**

- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved by manufacturers of joint sealants and of products in which joints occur.

### **3.5 PROTECTION**

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations with repaired areas are indistinguishable from the original work.

**END OF SECTION 32 13 73**

## **SECTION 321400 - UNIT PAVING**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Concrete pavers set in mortar setting beds.
  - 2. Steel edge restraints.
  - 3. Paver pedestals for installation above membrane or waterproofing.
- B. Related Sections:
  - 1. Division 07 Section "PVC Roofing."

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For materials other than water and aggregates.
- B. Samples: For each type of unit paver indicated and the following:
  - 1. Joint materials involving color selection.
  - 2. Paver pedestals.
- C. Shop Drawings:
  - 1. Show paving pattern in plan for concrete pavers set in mortar bed. Show edge details.
  - 2. Show paving pattern in plan for concrete pavers installed above membrane, including paver details.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

#### **1.5 QUALITY ASSURANCE**

- A. Mock-Up: Provide a mock-up of each location of paver installation for evaluation of surface preparation techniques and application workmanship.
  - 1. Finish areas designated by Architect.
  - 2. Do not proceed with remaining work until workmanship is approved by Architect.
  - 3. Refinish mock-up area as required to produce acceptable work.

#### **1.6 FIELD CONDITIONS**

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- B. Weather Limitations for Mortar and Grout:
  - 1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F (38 deg C) and higher.

## **PART 2 - PRODUCTS**

### **2.1 CONCRETE PAVERS**

- A. Concrete Pavers: Solid paving units complying with ASTM C1491, ASTM C-293, ASTM C-1028, ASTM-1262 & WTCL 99 made from concrete.
  1. Thickness: 2-1/4 inches
  2. Face Size and Shape:
    - a. 12 inches by 24 inches rectangular
    - b. 24 inches by 48 inches rectangular
    - c. 36 inches by 36 inches square
    - d. 12 inches by 48 inches rectangular
    - e. 24 inches by 36 inches rectangular
  3. Color & Finish:
    - a. Tectura HEP -30 (or approved equivalent)
    - b. Tectura HEP-20 (or approved equivalent)
    - c. Tectura HUF-35 (or approved equivalent)

### **2.2 EDGE RESTRAINTS**

- A. Steel Edge Restraints: Manufacturer's standard painted steel edging 3/16 inch thick by 6 inches high with pins anchored to the edge concrete base every 24 inches on center. Steel edge to always be concealed by adjacent grade and/or mulch.

### **2.3 PEDESTALS**

- A. Basis of Design: Provide Versadjust (V-series) paver pedestals as manufactured by Bison Innovative Products, or approved equivalent.
  1. Mineral filled high density copolymer polypropylene.
  2. Adjustable pedestals, as shown on Drawings:
    - a. For heights 1" to 7".
  3. Base Leveler Disks, as required:
    - a. Model LD4; 1/4" per foot each.
  4. Shims, as required:
    - a. Model B11; 1/16" flexible shim.
  5. Base Pad:
    - a. Model FIB; 12"x12"x11/16" pedestal base pad for use over low density insulation.
    - b. Provide at all locations where pedestal system bears on insulation.
- B. The contractor assumes the responsibility for and must take into consideration the structural capability and adequacy of the structure to carry the dead and live load weight(s) involved, and that the density of any insulation is satisfactory to resist crushing and damaging the waterproofing membrane.

### **2.4 ACCESSORIES**

- A. Cork Joint Filler: Preformed strips complying with ASTM D1752, Type II.
- B. Compressible Foam Filler: Preformed strips complying with ASTM D1056, Grade 2A1.

## **2.5 MORTAR SETTING-BED MATERIALS**

- A. Thinset Polymer-Modified Mortar ("Latex Mortar"): ANSI A118.4 Bonding Mortar
  - 1. Product: Laticrete Platinum 254 (or approved equivalent)
- B. Water: Potable

## **2.6 GROUT MATERIALS**

- A. High-Performance ("Latex Mortar") Cement Grout: ANSI A118.7.
  - 1. Product: Laticrete Permacolor Select (or approved equivalent)
- B. Grout Colors: Laticrete 45 Raven (or approved equivalent)
- C. Water: Potable.

## **2.7 MORTAR AND GROUT MIXES**

- A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimal performance characteristics. Discard mortars and grout if they have reached their initial set before being used.
- B. Mortar-Bed Bond Coat: Mix neat cement and latex additive to a creamy consistency.
- C. Latex-Modified, Portland Cement Setting-Bed Mortar: Proportion and mix portland cement, sand, and latex additive for setting bed to comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.
- D. Latex-Modified, Portland Cement Bond Coat: Proportion and mix portland cement, aggregate, and liquid latex for bond coat to comply with written instructions of liquid-latex manufacturer.
- E. Packaged Grout: Proportion and mix 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 clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
  - 1. For concrete pavers, a block splitter may be used.
- C. Joint Pattern: As indicated on plans.
- D. Tolerances: Do not exceed 1/16-inch (1.6-mm) unit-to-unit offset from flush (lippage) or 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 for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints. Install joint filler

before setting pavers. Sealant materials and installation are specified in Section 079200 "Joint Sealants."

- F. Expansion and Control Joints: Provide cork joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.
- G. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

### **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 mortar bed. Do not exceed 1/16-inch (1.6-mm) thickness for bond coat. Limit area of bond coat to avoid its drying out before placing setting bed.
- C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.
- D. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.
- E. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch- (1.5-mm-) thick bond coat to mortar bed or to back of each paver with a flat trowel.
- F. 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.
- G. Spaced Joint Widths: Provide 3/16-inch (10-mm) nominal joint width with variations not exceeding plus or minus 1/16 inch (1.5 mm).
- H. Grouted Joints: Grout paver joints complying with ANSI A108.10.
- 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, using a jointer larger than joint thickness unless otherwise indicated.
- 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.

### **3.3 PEDESTAL INSTALLATIONS**

- A. Provide a 12 x 12 inch piece of installed membrane be used as a separate protective slip sheet underneath each pedestal.
- B. Pedestals must be supported by a surface that provides 40 psi bearing capacity. Membranes installed over rigid insulation board typically incorporate 20 psi density insulation which requires additional support for adequate load bearing of 40 psi.
  - 1. Suggested methods to accomplish the noninvasive and required support:

2. Bison Model FIB Pedestal Base: Install an enlarged base that supports the pedestal to distribute the anticipated loaded weight of a pedestal over an enlarged area. Bison manufactures the Floating Insulation Base (Model FIB) for this purpose. Model FIB is specifically designed to be directly installed over Type 1 roof systems that incorporate 20 psi common insulation boards.
- C. Reference manufacturer Installation Details documentation for recommended installation procedures.
- D. During Installation:
1. Inspect construction progress regularly to ensure grid line spacing is being maintained in a straight and consistent manner and deck panels or pavers are level and not rocking, shim as required. Particular attention should be paid to pedestrian entrance or access points to eliminate potential trip hazards.
  2. Confirm that deck pedestal height does not exceed specified height.
  3. Unless otherwise specified in writing to allow for expansion, inspect to ensure that all paver spacing between tiles and at the perimeter is no greater than one tab set (not to exceed 3/16 inch or 4.5 mm). Install/Adhere partial tab sets as required to maintain proper gapping.
- E. Immediately Following Installation: The Owner, or the Owner's Agent, shall carefully inspect the deck system to verify:
1. The new deck is blocked on all sides to contain the surface decking and related components.
  2. There is no more than one tab set (not to exceed 3/16 inch or 4.5 mm) gapping between any deck panels and at all sides of the deck perimeter.
  3. Deck panels do not rock when you walk across the decking surface.
  4. All spacer tabs are in place, visible and secure.

### **3.4 WASTE MANAGEMENT**

- A. Minimize packaging required for material delivery without compromising protection of materials while either in transit to the project site or being stored on site.
- B. Separate waste (if any) in accordance with the Construction Waste Management Plan. Place in designated area for reuse or recycling. If recycling options are available locally or through manufacturer, recycle as a minimum, the following materials:
1. Aluminum.
  2. Plastic Materials
  3. Corrugated cardboard packaging.
- C. Separate the following categories for disposal and place in designated areas for hazardous materials:
1. Treated, stained, painted or contaminated wood.

**END OF SECTION 32 14 00**

## **SECTION 32 16 00 - CONCRETE CURBING**

### **PART 1 - GENERAL**

#### **1.1 SCOPE OF WORK**

- A. Preparation and Placement of Concrete Curb

#### **1.2 RELATED SECTIONS AND DOCUMENTS**

- A. Architectural Plans and Specifications as they relate specifically to cast-in-place concrete.
- B. New Jersey Department of Transportation Standard Specifications for Roads and Bridge Construction, latest edition.
- C. Contract Documents.

#### **1.3 REFERENCE STANDARDS**

- A. American Concrete Institute (ACI) latest edition
  - 301 Specifications for Structural Concrete for Buildings
  - 304R Guide for Measuring Mixing, Transporting and Placing Concrete
  - 308 Standard Practice for Curing Concrete
- B. American Society for Testing and Materials (ASTM) latest edition
  - A 185 Steel Welded Wire Fabric, Plain for Concrete Reinforcement
  - C497 Steel Welded Wire Fabric, Deformed, for Concrete Reinforcement
  - A615 Deformed and Plain Billet-Steel for Concrete Reinforcement
  - C33 Concrete Aggregates
  - C 94 Ready-Mixed Concrete
  - C 150 Portland Cement
  - C 260 Air-Entraining Admixtures for Concrete
  - D 309 Liquid Membrane-Forming Compounds for Curing Concrete
  - C494 Chemical Admixtures for Concrete
  - C1751 Performed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
- C. FS TT-C-800 - Curing Compound, Concrete, for New and Existing Surfaces.
- D. New Jersey Department of Transportation Standard Specification for Road and Bridge Construction, latest edition.

#### **1.4 QUALITY ASSURANCE**

- A. The Contractor shall warrant that concrete curbs are 4,500 psi.
- B. Establish and maintain required lines and elevations.
- C. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable work as directed by Owner.
- D. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.

- E. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of material.

## **1.5 SUBMITTALS**

- A. Submit concrete mix design to the Owner's Engineer for review and approval at least 14 days prior to use.

## **1.6 PROJECT CONDITIONS**

- A. Contractor shall maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. Forms: Steel, wood, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Use straight forms, free of distortion and defects. Use flexible spring steel forms or laminated boards to form radius bends as required. The forms shall be of a depth equal to the depth of curbing or sidewalk, and so designed as to permit secure fastening together at the tops. Coat forms with non-staining type coating that will not discolor or deface surface of concrete.
- B. Concrete Materials: Comply with requirements of the specifications and contract drawings for concrete materials, admixtures, bonding materials, curing materials and others as required. Concrete shall have a minimum 28-day compressive strength of 4,500 psi.
- C. Joint Fillers: Resilient pre-molded bituminous impregnated fiberboard units complying with ASTM D 1751 FS HH-F-341, Type II, Class A; or AASHTO M 153, Type I.

### **2.2 MIX DESIGN AND TESTING**

- A. Concrete mix design and testing shall comply with requirements of ACI.
- B. Design mix to produce normal weight concrete consisting of Portland cement, aggregate, water-reducing admixture, air-entraining admixture, and water to produce the following properties:
  1. Compressive Strength: 4,500 psi, minimum at 28 days, unless otherwise indicated on the Contract Drawings.
  2. Slump Range: 4-inches +/- 1-inch at time of placement
  3. Air Entrainment: 4 to 7 percent



## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Proof-roll prepared base material surface to check for unstable areas. The paving work shall begin after any unsuitable areas have been corrected and are ready to receive paving. Compaction testing for the base material shall be completed prior to the placement of the paving.
- B. Surface Preparation: Remove loose material from compacted base material surface to produce a firm, smooth surface immediately before placing concrete.

### **3.2 INSTALLATION**

- A. Form Construction
  - 1. Set forms to required grades and lines, rigidly braced and secured.
  - 2. Install sufficient quantity of forms to allow continuance of work and so that forms remain in place a minimum of 24 hours after concrete placement.
  - 3. Check completed formwork for grade and alignment to following tolerances:
    - a. Top of forms not more than 1/8-inch in 10-ft.
    - b. Vertical face on longitude axis, not more than 1/4-inch in 10-ft.
  - 4. Clean forms after each use, and coat with form release agent as often as required to ensure separation from concrete without damage.
- B. Concrete Placement
  - 1. Comply with applicable requirements of ACI and Architectural Specifications.
  - 2. Do not place concrete until base material and forms have been checked for line and grade. Moisten base material if required to provide uniform dampened condition at time concrete is placed. Concrete shall not be placed around manholes or other structures until they are at the required finish elevation and alignment.
  - 3. Place concrete using methods which prevent segregation of mix. Consolidate concrete along face of forms and adjacent to transverse joints with internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Consolidate with care to prevent dislocation of dowels, and joint devices.
  - 4. Deposit and spread concrete in continuous operation between transverse joints, as far as possible. If interrupted for more than 2 hours, place construction joint. Automatic machine may be used for curb and gutter placement at Contractor's option. Machine placement must produce curbs and gutters to required cross section, lines, grades, finish, and jointing as specified for formed concrete. If results are not acceptable, replace with formed concrete as specified.
  - 5. Concrete placement shall be conducted in accordance with related ACI recommended procedures.
- C. Joint Construction
  - 1. Transverse Expansion Joints: Transverse expansion joint in sidewalk shall have the filler cut to the exact cross section of the sidewalk. The joints shall be similar to the type of expansion joint used in the adjacent pavement. Expansion joints shall be 12' – 0" on center, maximum and tooled or sawn control joints shall be 4' – 0" on center maximum.
- D. Joint Fillers: Extend joint fillers full-width and depth of joint, and not less than 2-inches or more than 1-inch below finished surface where joint sealer is indicated. Furnish joint fillers in one-piece lengths for full width being placed, wherever possible. Where more than one length is required, lace or clip joint filler sections together.
- E. Joint Sealants: All joints shall be sealed with approved exterior pavement joint sealants and shall be installed per manufacturer's recommendations.

### **3.3 CONCRETE FINISHING**

- A. After striking off and consolidating concrete, smooth surface by screening and floating. Adjust floating to compact surface and produce uniform texture. After floating, test surface for trueness with 10-ft straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide continuous smooth finish.
- B. Work edges of sidewalks, gutters, back top edge of integral curb, and formed joints with an edging tool, and round to 2-inch radius. Eliminate tool marks on concrete surface. After completion of floating and troweling when excess moisture or surface sheen has disappeared, complete surface finishing as follows:
  - 1. Inclined Slab Surfaces: Provide coarse, non-slip finish by scoring surface with stiff-bristled broom perpendicular to line of traffic.
  - 2. Curbs, gutters, and sidewalks: Broom Finish by drawing fine-hair broom across surface perpendicular to line of traffic. Repeat operation as necessary to produce a fine line texture.
- C. Do not remove forms for 24 hours after concrete has been placed. After form removal, clean ends of joints and point up any minor honeycombed areas. Remove and replace areas or sections with major defects, as directed.
- D. Protect and cure finished concrete paving using acceptable moist-curing methods, more particularly described in the "water-curing" section of ACI 308-81.

### **3.4 BACKFILL**

- A. After the concrete has set sufficiently, the spaces in front and back of the curb and gutter or sidewalk shall be refilled to the required elevation with suitable material, which shall be compacted until firm and solid and neatly graded.

### **3.5 CLEANING AND ADJUSTING**

- A. Sweep concrete pavement and wash free of stains, discolorations, dirt, and other foreign material just prior to final inspection.
- B. Protect concrete from damage until acceptance of work. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials.

**END OF SECTION 32 16 00**

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## **SECTION 323113 - CHAIN LINK FENCES AND GATES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Chain-link fences.
  - 2. Swing gates.
  - 3. Privacy slats.

#### **1.2 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of fence and gate assembly.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each exposed product and for each color and texture specified.

#### **1.3 INFORMATIONAL SUBMITTALS**

- A. Product certificates.
- B. Product test reports.
- C. Sample warranty.

#### **1.4 WARRANTY**

- A. Special Warranty: Installer agrees to repair or replace components of chain-link fences and gates that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: 10 years from date of Substantial Completion.

### **PART 2 - PRODUCTS**

#### **2.1 CHAIN-LINK FENCE FABRIC**

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist according to "CLFMI Product Manual" and requirements indicated below:
  - 1. Fabric Height: As indicated on Drawings.
  - 2. Steel Wire for Fabric: Wire diameter of 9 gauge.
    - a. Mesh Size: 2 inches.
    - b. Polymer-Coated Fabric: ASTM F668, Class 2b over zinc-coated steel wire.
      - 1) Color: Black according to ASTM F934.
  - 3. Selvage: Knuckled at both selvages.

#### **2.2 FENCE FRAMEWORK**

- A. Posts and Rails: ASTM F1043 for framework, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F1043 or ASTM F1083 based on the following:
  - 1. Fence Height: As indicated on Drawings.
  - 2. Heavy-Industrial-Strength Material: Group IA, round steel pipe, Schedule 40.

- a. Line Post: 1.9 inches in diameter.
- b. End, Corner, and Pull Posts: 2.375 inches in diameter.
- 3. Horizontal Framework Members: top and bottom rails according to ASTM F1043.
- 4. Truss Rod Assembly: In compliance with ASTM f626, 3/8 in (9.53mm) diameter steel truss rod with pressed steel tightener), assembly capable of withstanding a tension of 2,000 lbs. (970 kg).
- 5. Metallic Coating for Steel Framework:
  - a. Type A zinc coating.
  - b. Type B zinc with organic overcoat.
  - c. External, Type B zinc with organic overcoat and internal, Type D zinc-pigmented coating.
  - d. Type C, Zn-5-Al-MM alloy coating.
  - e. Coatings: Any coating above.
- 6. Polymer coating over metallic coating.
  - a. Color: Match chain-link fabric, according to ASTM F934.

## **2.3 SWING GATES**

- A. General: ASTM F900 for gate posts and single and double swing gate types.
  - 1. Gate Leaf Width: As indicated.
  - 2. Framework Member Sizes and Strength: Based on gate fabric height as indicated.
- B. Pipe and Tubing:
  - 1. Zinc-Coated Steel: ASTM F1043 and ASTM F1083; protective coating and finish to match fence framework.
  - 2. Gate Posts: Round tubular steel.
  - 3. Gate Frames and Bracing: Round tubular steel.
- C. Frame Corner Construction: Welded.
- D. Hardware:
  - 1. Hinges: 180-degree outward swing.
  - 2. Latch: Permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.

## **2.4 FITTINGS**

- A. Provide fittings according to ASTM F626.
- B. Finish:
  - 1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz./sq. ft. of zinc.
    - a. Polymer coating over metallic coating.

## **2.5 PRIVACY SLATS**

- A. Tubular Polyethylene Slats: Minimum 0.023-inch-thick tubular polyethylene, manufactured for chain-link fences from virgin polyethylene with UV inhibitor, sized to fit mesh specified for direction indicated, with vandal-resistant fasteners and bottom lock strips.
- B. Color: Black

## **2.6 GROUT AND ANCHORING CEMENT**

- A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout, recommended in writing by manufacturer, for exterior applications.

- B. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating, and that is recommended in writing by manufacturer for exterior applications.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Do not begin installation before final grading is completed unless otherwise permitted by Architect.

#### **3.2 PREPARATION**

- A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

#### **3.3 CHAIN-LINK FENCE INSTALLATION**

- A. Install chain-link fencing according to ASTM F567 and more stringent requirements specified.
- B. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- C. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
  - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
  - 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
    - a. Concealed Concrete: Place top of concrete 2 inches below grade to allow covering with surface material.
- D. Terminal Posts: Install terminal end, corner, and gate posts according to ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of **15 degrees or more**. For runs exceeding 500 feet, space pull posts an equal distance between corner or end posts.
- E. Line Posts: Space line posts uniformly at 72 inches o.c.
- F. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 1-inch bottom clearance between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- G. Privacy Slats: Install slats in vertical direction, securely locked in place.

#### **3.4 ADJUSTING**

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

**END OF SECTION 323113**

## **SECTION 32 84 00 - PLANTING IRRIGATION (PERFORMANCE)**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Piping.
  - 2. Manual valves.
  - 3. Automatic control valves.
  - 4. Automatic drain valves.
  - 5. Sprinklers.
  - 6. Quick couplers.
  - 7. Controllers.
  - 8. Boxes for automatic control valves.

#### **1.2 PERFORMANCE REQUIREMENTS**

- A. Irrigation zone control shall be automatic operation with controller and automatic control valves.
- B. Delegated Design: Design 100 percent coverage irrigation system, including comprehensive engineering analysis by a qualified professional (certified irrigation designer or engineer), using performance requirements and design criteria indicated.
  - 1. Contractor is responsible for verifying soil conditions prior to completing design of irrigation system.
- C. Minimum Working Pressures: The following are minimum pressure requirements for piping, valves, and specialties unless otherwise indicated:
  - 1. Irrigation Main Piping: 200 psig (1380 kPa).
  - 2. Circuit Piping: 150 psig (1035 kPa).

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For irrigation systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional (certified irrigation designer or engineer) responsible for their preparation.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Zoning Chart: Show each irrigation zone and its control valve.
- B. Controller Timing Schedule: Indicate timing settings for each automatic controller zone.
- C. Field quality-control reports.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and maintenance data.

## 1.6 QUALITY ASSURANCE

- A. 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.

## PART 2 - PRODUCTS

### 2.1 PIPES, TUBES, AND FITTINGS

- A. Comply with requirements in the piping schedule for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.
- B. Galvanized-Steel Pipe: ASTM A53/A53M, Standard Weight, Type E, Grade B.
  - 1. Galvanized-Steel Pipe Nipples: ASTM A733, made of ASTM A53/A53M or ASTM A106/A106M, Standard Weight, seamless-steel pipe with threaded ends.
  - 2. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
  - 3. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface, and female threaded ends.
  - 4. Cast-Iron Flanges: ASME B16.1, Class 125.
- C. Ductile-Iron Pipe with Push-on Joint: AWWA C151, with push-on-joint bell and spigot ends.
  - 1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
    - a. Gaskets: AWWA C111, rubber.
- D. Soft Copper Tube: ASTM B88, Type L (ASTM B88M, Type B), water tube, annealed temper.
  - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper solder-joint fittings. Furnish wrought-copper fittings if indicated.
  - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end.
  - 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- E. Hard Copper Tube: ASTM B88, Type L (ASTM B88M, Type B), and ASTM B88, Type M (ASTM B88M, Type C), water tube, drawn temper.
  - 1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper solder-joint fittings. Furnish wrought-copper fittings if indicated.
  - 2. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end.
  - 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces and solder-joint or threaded ends.
- F. PE Pipe with Controlled ID: ASTM F771, PE 3408 compound; SDR 11.5 and SDR 15.
  - 1. Insert Fittings for PE Pipe: ASTM D2609, nylon or propylene plastic with barbed ends. Include bands or other fasteners.
- G. PVC Pipe: ASTM D1785, PVC 1120 compound, Schedule 40.
  - 1. PVC Socket Fittings: ASTM D2466, Schedule 40.
  - 2. PVC Threaded Fittings: ASTM D2464, Schedule 80.
  - 3. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket ends.
- H. PVC Pipe, Pressure Rated: ASTM D2241, PVC 1120 compound, SDR 21 and SDR 26.
  - 1. PVC Socket Fittings: ASTM D2467, Schedule 80.
  - 2. PVC Socket Unions: Construction similar to MSS SP-107, except both headpiece and tailpiece shall be PVC with socket or threaded ends.

## 2.2 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick unless otherwise indicated; full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.
- D. Solder Filler Metals: ASTM B32, lead-free alloys. Include water-flushable flux according to ASTM B813.
- E. Solvent Cements for Joining PVC Piping: ASTM D2564. Include primer according to ASTM F656.
- F. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

## 2.3 MANUAL VALVES

- A. Curb Valves:
  - 1. Description:
    - a. Standard: AWWA C800.
    - b. NPS 1 (DN 25) and Smaller Pressure Rating: 100 psig (690 kPa) minimum.
    - c. NPS 1-1/4 to NPS 2 (DN 32 to DN 50) Pressure Rating: 80 psig (550 kPa) minimum.
    - d. Body Material: Brass or bronze with ball or ground-key plug.
    - e. End Connections: Matching piping.
    - f. Stem: With wide-tee head.
- B. Curb-Valve Casing:
  - 1. Standard: Similar to AWWA M44 for cast-iron valve casings.
  - 2. Top Section: Telescoping, of length required for depth of burial of curb valve.
  - 3. Barrel: Approximately 3-inch (75-mm) diameter.
  - 4. Plug: With lettering "WATER."
  - 5. Bottom Section: With base of size to fit over valve.
  - 6. Base Support: Concrete collar.
- C. Shutoff Rods for Curb-Valve Casings: Furnish **one** steel, tee-handle shutoff rod(s) with one pointed end, stem of length to operate deepest buried valve, and slotted end matching curb valve for Project.
- D. Brass Ball Valves:
  - 1. Description:
    - a. Standard: MSS SP-110.
    - b. SWP Rating: 150 psig (1035 kPa).
    - c. CWP Rating: 600 psig (4140 kPa).
    - d. Body Design: Two piece.
    - e. Body Material: Forged brass.
    - f. Ends: Threaded or solder joint if indicated.
    - g. Seats: PTFE or TFE.
    - h. Stem: Brass.
    - i. Ball: Chrome-plated brass.
    - j. Port: Full.
- E. Bronze Ball Valves:
  - 1. Description:



- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig (1035 kPa).
- c. CWP Rating: 600 psig (4140 kPa).
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded or solder joint if indicated.
- g. Seats: PTFE or TFE.
- h. Stem: Bronze.
- i. Ball: Chrome-plated brass.
- j. Port: Full.

F. Iron Ball Valves:

- 1. Description:
  - a. Standard: MSS SP-72.
  - b. CWP Rating: 200 psig (1380 kPa).
  - c. Body Design: Split body.
  - d. Body Material: ASTM A126, gray iron.
  - e. Ends: Flanged.
  - f. Seats: PTFE or TFE.
  - g. Stem: Stainless steel.
  - h. Ball: Stainless steel.
  - i. Port: Full.

G. Plastic Ball Valves:

- 1. Description:
  - a. Standard: MSS SP-122.
  - b. Pressure Rating: 125 psig (860 kPa) minimum.
  - c. Body Material: PVC.
  - d. Type: Union.
  - e. End Connections: Socket or threaded.
  - f. Port: Full.

H. Iron Gate Valves, Resilient Seated:

- 1. Description:
  - a. Standard: AWWA C509.
  - b. Pressure Rating: 200 psig (1380 kPa) minimum.
  - c. Body Material: Ductile or gray iron with bronze trim.
  - d. End Connections: Mechanical joint or push-on joint.
  - e. Interior Coating: Comply with AWWA C550.
  - f. Body Design: Nonrising stem.
  - g. Operator: Stem nut.
  - h. Disc: Solid wedge with resilient coating.

I. Iron Gate Valve Casings:

- 1. Standard: AWWA M44 for cast-iron valve casings.
- 2. Top Section: Adjustable extension of length required for depth of burial of valve.
- 3. Barrel: Approximately 5-inch (125-mm) diameter.
- 4. Plug: With lettering "WATER."
- 5. Bottom Section: With base of size to fit over valve.
- 6. Base Support: Concrete collar.

- J. Operating Wrenches for Iron Gate Valve Casings: Furnish one steel, tee-handle operating wrench(es) with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut for Project.

## 2.4 AUTOMATIC CONTROL VALVES

- A. Bronze, Automatic Control Valves:

1. Description: Cast-bronze body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac solenoid.
- B. Plastic, Automatic Control Valves:
1. Description: Molded-plastic body, normally closed, diaphragm type with manual-flow adjustment, and operated by 24-V ac solenoid.

## 2.5 AUTOMATIC DRAIN VALVES

- A. Description: Spring-loaded-ball type of corrosion-resistant construction and designed to open for drainage if line pressure drops below 2-1/2 to 3 psig (17 to 20 kPa).

## 2.6 SPRINKLERS

- A. General Requirements: Designed for uniform coverage over entire spray area indicated at available water pressure.
- B. Plastic, Exposed, Impact-Drive Rotary Sprinklers:
1. Description:
    - a. Construction: ABS and corrosion-resistant metals.
    - b. Mounting: Aboveground, exposed on riser.
- C. Plastic, Pop-up, Gear-Drive Rotary Sprinklers:
1. Description:
    - a. Body Material: ABS.
    - b. Nozzle: Brass.
    - c. Retraction Spring: Stainless steel.
    - d. Internal Parts: Corrosion resistant.
- D. Plastic, Pop-up, Impact-Drive Rotary Sprinklers:
1. Description:
    - a. Case: ABS.
    - b. Pop-up Height: 4 inches (100 mm) aboveground to nozzle.
    - c. Sprinkler Construction: ABS and other corrosion-resistant metals.
- E. Plastic, Surface Spray Sprinklers:
1. Description:
    - a. Body Material and Flange: ABS.
    - b. Pattern: Fixed, with flow adjustment.
- F. Plastic, Surface, Pop-up Spray Sprinklers:
1. Description:
    - a. Body Material and Flange: ABS.
    - b. Pattern: Fixed, with flow adjustment.
- G. Plastic, Pop-up Spray Sprinklers:
1. Description:
    - a. Body Material: ABS.
    - b. Nozzle: Brass.
    - c. Retraction Spring: Stainless steel.
    - d. Internal Parts: Corrosion resistant.
    - e. Pattern: Fixed, with flow adjustment.
- H. Plastic Shrub Sprinklers:
1. Description:
    - a. Body Material: ABS or other plastic.
    - b. Pattern: Fixed, with flow adjustment.

## 2.7 QUICK COUPLERS

- A. Description: Factory-fabricated, bronze or brass, two-piece assembly. Include coupler water-seal valve; removable upper body with spring-loaded or weighted, rubber-covered cap; hose swivel with ASME B1.20.7, 3/4-11.5NH threads for garden hose on outlet; and operating key.
1. Locking-Top Option: Vandal-resistant locking feature. Include two matching key(s).

## 2.8 CONTROLLERS

- A. Description:
1. Controller Stations for Automatic Control Valves: Each station is variable from approximately 5 to 60 minutes. Include switch for manual or automatic operation of each station.
  2. Exterior Control Enclosures: NEMA 250, Type 4, weatherproof, with locking cover and two matching keys; include provision for grounding.
    - a. Body Material: Enameled-steel sheet metal.
    - b. Mounting: Surface type for wall.
  3. Interior Control Enclosures: NEMA 250, Type 12, dripproof, with locking cover and two matching keys.
    - a. Body Material: Enameled-steel sheet metal.
    - b. Mounting: Surface type for wall.
  4. Control Transformer: 24-V secondary, with primary fuse.
  5. Timing Device: Adjustable, 24-hour, 14-day clock, with automatic operations to skip operation any day in timer period, to operate every other day, or to operate two or more times daily.
    - a. Manual or Semiautomatic Operation: Allows this mode without disturbing preset automatic operation.
    - b. Nickel-Cadmium Battery and Trickle Charger: Automatically powers timing device during power outages.
    - c. Surge Protection: Metal-oxide-varistor type on each station and primary power.
  6. Moisture Sensor: Adjustable from one to seven days, to shut off water flow during rain.
  7. Wiring: UL 493, Type UF multiconductor, with solid-copper conductors; insulated cable; suitable for direct burial.
    - a. Feeder-Circuit Cables: No. 12 AWG minimum, between building and controllers.
    - b. Low-Voltage, Branch-Circuit Cables: No. 14 AWG minimum, between controllers and automatic control valves; color-coded different from feeder-circuit-cable jacket color; with jackets of different colors for multiple-cable installation in same trench.
    - c. Splicing Materials: Manufacturer's packaged kit consisting of insulating, spring-type connector or crimped joint and epoxy resin moisture seal; suitable for direct burial.

## 2.9 BOXES FOR AUTOMATIC CONTROL VALVES

- A. Plastic Boxes:
1. Description: Box and cover, with open bottom and openings for piping; designed for installing flush with grade.
    - a. Size: As required for valves and service.
    - b. Sidewall Material: PE, ABS, or FRP.
    - c. Cover Material: PE, ABS, or FRP.
      - 1) Lettering: IRRIGATION.
- B. Drainage Backfill: Cleaned gravel or crushed stone, graded from 3/4 inch (19 mm) minimum to 3 inches (75 mm) maximum.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

- B. Install warning tape directly above pressure piping, 12 inches (300 mm) below finished grades, except 6 inches (150 mm) below subgrade under pavement and slabs.
- C. Drain Pockets: Excavate to sizes indicated. Backfill with cleaned gravel or crushed stone, graded from 3/4 to 3 inches (19 to 75 mm), to 12 inches (300 mm)] below grade. Cover gravel or crushed stone with sheet of asphalt-saturated felt and backfill remainder with excavated material.
- D. Provide minimum cover over top of underground piping according to the following:
  1. Irrigation Main Piping: Minimum depth of 36 inches (900 mm) below finished grade, or not less than 18 inches (450 mm) below average local frost depth, whichever is deeper.
  2. Circuit Piping: 12 inches (300 mm).
  3. Drain Piping: 12 inches (300 mm).
  4. Sleeves: 24 inches (600 mm).

### **3.2 PIPING INSTALLATION**

- A. Location and Arrangement: Drawings indicate location and arrangement of piping systems. Install piping as indicated unless deviations are approved on Coordination Drawings.
- B. Install piping at minimum uniform slope of 0.5 percent down toward drain valves.
- C. Install piping free of sags and bends.
- D. Install groups of pipes parallel to each other, spaced to permit valve servicing.
- E. Install fittings for changes in direction and branch connections.
- F. Install unions adjacent to valves and to final connections to other components with NPS 2 (DN 50) or smaller pipe connection.
- G. Install flanges adjacent to valves and to final connections to other components with NPS 2-1/2 (DN 65) or larger pipe connection.
- H. Install underground thermoplastic piping according to ASTM D2774 and ASTM F690.
- I. Install expansion loops in control-valve boxes for plastic piping.
- J. Lay piping on solid subbase, uniformly sloped without humps or depressions.
- K. Install ductile-iron piping according to AWWA C600.
- L. Install PVC piping in dry weather when temperature is above 40 deg F (5 deg C). Allow joints to cure at least 24 hours at temperatures above 40 deg F (5 deg C) before testing.

### **3.3 JOINT CONSTRUCTION**

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- D. Flanged Joints: Select rubber gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- E. Ductile-Iron Piping Gasketed Joints: Comply with AWWA C600 and AWWA M41.
- F. Copper-Tubing Brazed Joints: Construct joints according to CDA's "Copper Tube Handbook," using copper-phosphorus brazing filler metal.
- G. Copper-Tubing Soldered Joints: Apply ASTM B813 water-flushable flux to tube end unless otherwise indicated. Construct joints according to ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy (0.20 percent maximum lead content) complying with ASTM B32.
- H. PE Piping Fastener Joints: Join with insert fittings and bands or fasteners according to piping manufacturer's written instructions.
- I. PVC Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
  2. PVC Pressure Piping: Join schedule number, ASTM D1785, PVC pipe and PVC socket fittings according to ASTM D2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D2855.
  3. PVC Nonpressure Piping: Join according to ASTM D2855.

### **3.4 VALVE INSTALLATION**

- A. Underground Curb Valves: Install in curb-valve casings with tops flush with grade.
- B. Underground Iron Gate Valves, Resilient Seat: Comply with AWWA C600 and AWWA M44. Install in valve casing with top flush with grade.
  1. Install valves and PVC pipe with restrained, gasketed joints.
- C. Aboveground Valves: Install as components of connected piping system.
- D. Throttling Valves: Install in underground piping in boxes for automatic control valves.
- E. Drain Valves: Install in underground piping in boxes for automatic control valves.

### **3.5 SPRINKLER INSTALLATION**

- A. Install sprinklers after hydrostatic test is completed.
- B. Install sprinklers at manufacturer's recommended heights.
- C. Locate part-circle sprinklers to maintain a minimum distance of 4 inches (100 mm) from walls and 2 inches (50 mm) from other boundaries unless otherwise indicated.

### **3.6 AUTOMATIC IRRIGATION-CONTROL SYSTEM INSTALLATION**

- A. Equipment Mounting: Install interior controllers on wall.
  1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  2. Install anchor bolts to elevations required for proper attachment to supported equipment.

- B. Equipment Mounting: Install exterior freestanding controllers on precast concrete bases.
  1. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  2. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Install control cable in same trench as irrigation piping and at least 2 inches (51 mm) below or beside piping. Provide conductors of size not smaller than recommended by controller manufacturer. Install cable in separate sleeve under paved areas.

### **3.7 IDENTIFICATION**

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplates and signs on each automatic controller.
  1. Text: In addition to identifying unit, distinguish between multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- C. Warning Tapes: Arrange for installation of continuous, underground, detectable warning tapes over underground piping during backfilling of trenches. See Section 312000 "Earth Moving" for warning tapes.

### **3.8 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Tests and Inspections:
  1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  2. Operational Test: After electrical circuitry has been energized, operate controllers and automatic control valves to confirm proper system operation.
  3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Any irrigation product will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

### **3.9 ADJUSTING**

- A. Adjust settings of controllers.
- B. Adjust automatic control valves to provide flow rate at rated operating pressure required for each sprinkler circuit.
- C. Adjust sprinklers and devices, except those intended to be mounted aboveground, so they will be flush with, or not more than 1/2 inch (13 mm) above, finish grade.

### **3.10 PIPING SCHEDULE**

- A. Install components having pressure rating equal to or greater than system operating pressure.
- B. Piping in control-valve boxes and aboveground may be joined with flanges or unions instead of joints indicated.
- C. Aboveground irrigation main piping, NPS 4 (DN 100) and smaller shall be one of the following:

1. Galvanized-steel pipe and galvanized-steel pipe nipples; galvanized, gray-iron threaded fittings; and threaded joints.
  2. Type L (Type B) hard copper tube, wrought- or cast-copper fittings, and soldered joints.
  3. Schedule 40, PVC pipe; socket-type PVC fittings; and solvent-cemented joints.
  4. Schedule 80, PVC pipe; Schedule 80, threaded PVC fittings; and threaded joints.
- D. Underground irrigation main piping, NPS 4 (DN 100) and smaller, shall be one of the following:
1. NPS 3 and NPS 4 (DN 80 and DN 100) ductile-iron, push-on-joint pipe; ductile-iron, push-on-joint fittings and gaskets; and gasketed joints.
  2. Type L (Type B) soft copper tube, wrought-copper fittings, and brazed joints.
  3. Schedule 40, PVC pipe and socket fittings, and solvent-cemented joints.
  4. Schedule 80, PVC pipe; Schedule 80, threaded PVC fittings; and threaded joints.
  5. SDR 21, PVC, pressure-rated pipe; Schedule 80, PVC socket fittings; and solvent-cemented joints.
- E. Circuit piping, NPS 2 (DN 50) and smaller, shall be one of the following:
1. SIDR 7, PE, controlled ID pipe; insert fittings for PE pipe; and fastener joints.
  2. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.
  3. SDR 26, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-cemented joints.
- F. Circuit piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
1. SIDR 7, PE, controlled ID pipe; insert fittings for PE pipe; and banded or fastener joints.
  2. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.
  3. SDR 26, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-cemented joints.
- G. Underground Branches and Offsets at Sprinklers and Devices: Schedule 80, PVC pipe; threaded PVC fittings; and threaded joints.
1. Option: Plastic swing-joint assemblies, with offsets for flexible joints, manufactured for this application.
- H. Risers to Aboveground Sprinklers and Specialties: Type L (Type B) hard copper tube, wrought-copper fittings, and soldered joints.
- I. Risers to Aboveground Sprinklers and Specialties: Schedule 80, PVC pipe and socket fittings; and solvent-cemented joints.
- J. Drain piping shall be one of the following:
1. SIDR 9, 11.5, or 15, PE, controlled ID pipe; insert fittings for PE pipe; and banded or fastener joints.
  2. Schedule 40, PVC pipe and socket fittings; and solvent-cemented joints.
  3. SDR 21, 26, or 32.5, PVC, pressure-rated pipe; Schedule 40, PVC socket fittings; and solvent-cemented joints.

### **3.11 VALVE SCHEDULE**

- A. Underground, Shutoff-Duty Valves: Use the following:
1. NPS 2 (DN 50) and Smaller: Curb valve, curb-valve casing, and shutoff rod.
  2. NPS 3 (DN 80) and Larger: Iron gate valve, resilient seated; iron gate valve casing; and operating wrench(es).
- B. Aboveground, Shutoff-Duty Valves:
1. NPS 2 (DN 50) and Smaller: Brass ball valve.
  2. NPS 2-1/2 (DN 65) and Larger: Iron ball valve.
- C. Throttling-Duty Valves:
1. NPS 2 (DN 50) and Smaller: Plastic automatic control valve.

2. NPS 2-1/2 and NPS 3 (DN 65 and DN 80): Plastic automatic control valve.

D. Drain Valves:

1. NPS 1/2 and NPS 3/4 (DN 15 and DN 20): Automatic drain valve.
2. NPS 1 to NPS 2 (DN 25 to DN 50): Brass ball valve.

**3.12 GUARANTEE**

- A. The entire sprinkler system shall be guaranteed by the Contractor to give complete and satisfactory service as to materials and workmanship for a period of one year from the date of Substantial Completion.
- B. Any settling of backfilled trenches shall be repaired by the Contractor at the Contractor's expense, including but not limited to, restoration of pavement, seeded, sodded, and/or planted areas.

**END OF SECTION 32 84 00**



## **SECTION 32 91 13 - SOIL PREPARATION (PERFORMANCE)**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section includes planting soils specified according to performance requirements of the mixes.
- B. Related Requirements:
  - 1. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.

#### **1.2 DEFINITIONS**

- A. CEC: Cation exchange capacity.
- B. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- C. Imported Soil: Soil that is transported to Project site for use.
- D. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
- E. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."
- F. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- G. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.
- H. SSSA: Soil Science Society of America.
- I. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
- J. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- K. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
- L. USCC: U.S. Composting Council.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Sustainable Design Submittals:
  - 1. Product Certificates: For regional materials, indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include distance to Project and cost for each regional material.

- C. Samples: For each bulk-supplied material in sealed containers labeled with content, source, and date obtained; providing an accurate representation of composition, color, and texture.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.

#### **1.5 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- A. Regional Materials: Imported soil, manufactured planting soil and soil amendments and fertilizers shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.

#### **2.2 PLANTING SOILS SPECIFIED ACCORDING TO PERFORMANCE REQUIREMENTS**

- A. All complying planting soils to meet the following requirements:
  1. Fragment Size Distribution meets one of the following criteria (percentages measured by dry weight) for USDA texture classification as sandy loam soil:
    - a. Sandy Loam - Option A Criteria
      - 1) Clay (<0.002 mm) percentage is between 7 to 20 percent
      - 2) Silt (0.05 – 0.002 mm) percentage plus twice the percentage of Clay (<0.002 mm) is greater than 30 percent total
      - 3) Sand (2.0 – 0.05 mm) percentage is greater than 52 percent
    - b. Sandy Loam – Option B Criteria
      - 1) Clay (<0.002 mm) percentage is less than 7 percent
      - 2) Silt (0.05 -0.002 mm) percentage is less than 50%
      - 3) Silt (0.05 – 0.002 mm) percentage plus twice the percentage of Clay (<0.002 mm) is greater than 30 percent total
  2. Percentage of Organic Matter: 5 to 10 percent by dry weight
  3. Soil Reaction: pH of 6 to 7.
  4. CEC of Total Soil: Minimum 10 meq/100 mL at pH of 7.0.
  5. Soluble-Salt Content: 2.00 mmhos/cm maximum measured by electrical conductivity.
  6. Bulk Density: 1.0 g/cu. cm to 1.1 g/cu. cm at 85 percent compaction.
  7. Total Porosity: Minimum 50 percent at 85 percent compaction.
  8. Macro Porosity: Minimum 10 percent at 85 percent compaction.
  9. Fertility: Nutrients and nutrient quantities as per soil testing laboratory's recommendations to obtain soil chemistry suitable for growing the plants specified.
  10. Microbiological Content: As per soil testing laboratory's recommendations to obtain soil chemistry suitable for growing the plants specified.
  11. RCRA Metals: Below maximum limits established by the EPA.
  12. Phytotoxicity: Below phytotoxicity limits established by SSSA.
- B. Existing Planting Soil: Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce viable planting soil. Using preconstruction soil analyses and materials specified in other articles of this Section, amend existing, on-site surface soil to become complying planting soil.

- C. Imported Soil: Imported, naturally formed soil from off-site sources and consisting of sandy loam soil according to USDA textures; and modified to produce viable planting soil. Amend imported soil with materials specified in other articles of this Section to become complying planting soil.
1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches (100 mm) deep, not from agricultural land, bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.
  2. Additional Properties of Imported Soil before Amending: Minimum of 5 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration. Clean soil to be of the following:
    - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
    - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 8 percent by dry weight of the imported soil.
    - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 2 inches (50 mm) in any dimension.
- D. Manufactured Soil: Manufactured soil consisting of manufacturer's basic sandy loam according to USDA textures blended in a manufacturing facility with sand, stabilized organic soil amendments, and other materials as specified in other articles of this Section to produce viable planting soil.
1. Basic Properties: Manufactured soil shall not contain the following:
    - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
    - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the manufactured soil.
    - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 1-1/2 inches (38 mm) in any dimension.

### 2.3 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent.
- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through a No. 40 (0.425-mm) sieve.
- C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
- D. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through a No. 50 (0.30-mm) sieve.
- E. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C33/C33M.

## **2.4 ORGANIC SOIL AMENDMENTS**

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
  - 1. Feedstock: Limited to leaves.
  - 2. Reaction: pH of 5.5 to 8.
  - 3. Soluble-Salt Concentration: Less than 4 dS/m.
  - 4. Moisture Content: 35 to 55 percent by weight.
  - 5. Organic-Matter Content: 30 to 60 percent of dry weight.
  - 6. Particle Size: Minimum of 98 percent passing through a 2-inch (50-mm) sieve.
- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, a pH of 3.4 to 4.8, and a soluble-salt content measured by electrical conductivity of maximum 5 dS/m.
- C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, a pH of 6 to 7.5, a soluble-salt content measured by electrical conductivity of maximum 5 dS/m, having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.
- D. Wood Derivatives: Shredded and composted, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
- E. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

## **2.5 FERTILIZERS**

- A. Superphosphate: Commercial, phosphate mixture, soluble.
- B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium.

## **PART 3 - EXECUTION**

### **3.1 GENERAL**

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.
- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.

### **3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING**

- A. Excavation: Excavate soil from designated area(s) to a depth indicated on drawings and stockpile until amended.
- B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.

- C. Unsuitable Materials: Clean soil to contain a combined maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.

### **3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE**

- A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 4 inches (100 mm). Remove stones larger than 3 inches (75 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Spread unamended soil to total depth indicated on Drawings, but not less than required to meet finish grades after mixing with amendments and natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
  - 1. Amendments: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them with unamended soil to produce planting soil.
    - a. Mix lime and] sulfur with dry soil before mixing fertilizer.
    - b. Mix fertilizer with planting soil no more than seven days before planting.
  - 2. Lifts: Apply and mix unamended soil and amendments in lifts not exceeding 12 inches (300 mm)] in loose depth for material compacted by compaction equipment, and not more than 6 inches (150 mm) in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

### **3.4 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE**

- A. General: Apply manufactured soil on-site in its final, blended condition. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth indicated on drawings. Remove stones larger than 3 inches (75 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Application: Spread planting soil to total depth indicated on Drawings, but not less than required to meet finish grades after natural settlement. Do not spread if soil or subgrade is frozen, muddy, or excessively wet.
  - 1. Lifts: Apply planting soil in lifts not exceeding 12 inches (300 mm) in loose depth for material compacted by compaction equipment, and not more than 6 inches (150 mm) in loose depth for material compacted by hand-operated tampers.
- D. Compaction: Compact each lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

### **3.5 BLENDING PLANTING SOIL IN PLACE**

- A. General: Mix amendments with in-place, unamended soil to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.

- B. Preparation: Till unamended, existing soil in planting areas to a minimum depth indicated on Drawings. Remove stones larger than 3 inches (75 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
- C. Mixing: Apply soil amendments and fertilizer, if required, evenly on surface, and thoroughly blend them into full depth of unamended, in-place soil to produce planting soil.
  - 1. Mix lime and sulfur with dry soil before mixing fertilizer.
  - 2. Mix fertilizer with planting soil no more than seven days before planting.
- D. Compaction: Compact blended planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D698.
- E. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

### **3.6 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests:
  - 1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D698. Space tests at no less than one for each 2000 sq. ft. (200 sq. m) of in-place soil or part thereof.
  - 2. Performance Testing: For each amended planting-soil type, demonstrating compliance with specified performance requirements. Perform testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
- C. Soil will be considered defective if it does not pass tests.
- D. Prepare test reports.
- E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

### **3.7 PROTECTION AND CLEANING**

- A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."
- B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
  - 1. Storage of construction materials, debris, or excavated material.
  - 2. Parking vehicles or equipment.
  - 3. Vehicle traffic.
  - 4. Foot traffic.
  - 5. Erection of sheds or structures.
  - 6. Impoundment of water.
  - 7. Excavation or other digging unless otherwise indicated.
- C. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.
  - 1. Dispose of excess subsoil and unsuitable materials off-site.

**END OF SECTION 32 91 13**

## **SECTION 32 92 00 – TURF & GRASSES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Seeding.

#### **1.2 DEFINITIONS**

- A. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- B. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation and drawing designations for planting soils.

#### **1.3 PREINSTALLATION MEETINGS**

- A. Preinstallation Conference: Conduct conference at Project site

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Certification of grass seed.
- B. Product certificates.

#### **1.5 QUALITY ASSURANCE**

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
  - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  - 2. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the National Association of Landscape Professionals:
    - a. Landscape Industry Certified Technician - Exterior.
    - b. Landscape Industry Certified Lawn Care Manager.
    - c. Landscape Industry Certified Lawn Care Technician.
  - 3. Pesticide Applicator: State licensed, commercial.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
- B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" sections in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod within 24 hours of harvesting and in time for planting promptly. Protect sod from breakage and drying.

## **PART 2 - PRODUCTS**

### **2.1 SEED**

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species:
  - 1. Quality: State-certified seed of grass species as listed below for solar exposure.
  - 2. Full Sun: Proportioned by weight as follows:
    - a. 85% *Poa pratensis* (Kentucky Bluegrass)
    - b. 15% *Lolium perenne* (Perennial Ryegrass)
    - c. seed seeding rate of 4 lbs per 1,000 square feet
  - 3. Partial Sun and Partial Shade: Proportioned by weight as follows:
    - a. 25% *Festuca rubra* var. *commutate* (Chewing Fescue)
    - b. 25% *Festuca rubra* (Native Red Fescue)
    - c. 40% *Poa pratensis* (Kentucky Bluegrass)
    - d. 10% *Lolium perenne* (Perennial Ryegrass)
    - e. seed seeding rate of 4 lbs per 1,000 square feet
  - 4. Shade: Proportioned by weight as follows:
    - a. 40% *Festuca rubra* var. *commutate* (Chewing Fescue)
    - b. 40% *Festuca rubra* (Native Red Fescue)
    - c. 20% *Poa Trivialis* (Rough Bluegrass)
    - d. seed seeding rate of 4.5 lbs per 1,000 square feet

### **2.2 FERTILIZERS**

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
  - 1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

### **2.3 MULCHES**

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
  - 1. Organic Matter Content: 50 to 60 percent of dry weight
  - 2. Feedstock: Agricultural, food, or industrial residuals; biosolids, yard trimmings; or source-separated or compostable mixed solid waste

### **2.4 PESTICIDES**

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.



## **PART 3 - EXECUTION**

### **3.1 TURF AREA PREPARATION**

- A. General: Prepare planting area for soil placement and mix planting soil according to Division 32 Section "Soil Preparation."
- B. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

### **3.2 SEEDING**

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
  - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
  - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
  - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a minimum total rate of 4 lb/1000 sq. ft. as indicated specific to each sun/shade mix.
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas.
  - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
- E. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch or planting soil within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16, and roll surface smooth.

### **3.3 TURF MAINTENANCE**

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
- B. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings.

### **3.4 SATISFACTORY TURF**

- A. Turf installations shall meet the following criteria as determined by Landscape Architect:
  - 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 95 percent over any 10 sq. ft. and bare spots not exceeding 3 by 3 inches.
- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

**END OF SECTION 32 92 00**

## **SECTION 32 93 00 - PLANTS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Plants.
  - 2. Tree stabilization.
  - 3. Tree grates.
- B. Related Requirements:
  - 1. Division 01 Section "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
  - 2. Division 03 Section "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

#### **1.3 DEFINITIONS**

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.
- D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than the minimum root spread according to ANSI Z60.1 for type and size of plant required.
- E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
- F. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.
- G. Finish Grade: Elevation of finished surface of planting soil.
- H. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.

- I. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- J. Planting Area: Areas to be planted.
- K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329113 "Soil Preparation" for drawing designations for planting soils.
- L. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
- M. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
- N. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
- O. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

#### **1.4 COORDINATION**

- A. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
  - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

#### **1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
  - 2. Plant Photographs: Include color photographs in digital 3- by 5-inch print format of each required species and size of plant material as it will be furnished to the Project. Take photographs from an angle depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 20 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.
- B. Samples for Verification: For each of the following:
  - 1. Trees and Large Shrubs: The Contractor shall tag all Balled & Burlapped Plant Material at a nursery for review by the Landscape Architect at a later visit. The Contractor must submit Plant Photographs first prior to requesting nursery visit. Landscape Architect may determine that Plant Photograph submission is adequate for approval of tagged Trees and Large Shrubs.
  - 2. Organic Mulch: 1-pint volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
  - 3. Proprietary Root-Ball-Stabilization Device: One unit.
  - 4. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.
  - 5. Root Barrier: Width of panel by 12 inches.

## **1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
  - 1. Manufacturer's certified analysis of standard products.
  - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.
- D. Sample Warranty: For special warranty.

## **1.7 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods. Format of Maintenance Data to be provided to Owner in a 3-ring binder and must describe pruning, fertilizing and watering instructions for each plant type installed.

## **1.8 QUALITY ASSURANCE**

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
  - 1. Experience: Three years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
  - 2. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
- B. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
  - 1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches (150 mm) above the root flare for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above the root flare for larger sizes.
  - 2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
- C. Plant Material Observation: Landscape Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Landscape Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
  - 1. Notify Landscape Architect of sources of planting materials fourteen business days in advance of delivery to site.

## **1.9 DELIVERY, STORAGE, AND HANDLING**

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.

- B. Bulk Materials:
  1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  3. Accompany each delivery of bulk materials with appropriate certificates.
- C. Deliver bare-root stock plants within 24 hours of digging. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting. Transport in covered, temperature-controlled vehicles, and keep plants cool and protected from sun and wind at all times.
- D. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- E. Handle planting stock by root ball.
- F. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F (16 to 18 deg C) until planting.
- G. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.
- H. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
  1. Heel-in bare-root stock. Soak roots that are in less than moist condition in water for two hours. Reject plants with dry roots.
  2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
  3. Do not remove container-grown stock from containers before time of planting.
  4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.

#### **1.10 FIELD CONDITIONS**

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- B. Planting Restrictions: Plant the following plants during one of the following periods, unless otherwise directed by the Landscape Architect. Coordinate planting periods with maintenance periods to provide required maintenance from date of Substantial Completion.
  1. Deciduous Woody Plants: Only between March 1<sup>st</sup> to May 15<sup>th</sup> and October 15<sup>th</sup> to December 15<sup>th</sup>.
  2. Evergreen Plants: Only between April 1<sup>st</sup> to May 15<sup>th</sup> and September 1<sup>st</sup> to October 15<sup>th</sup>.
- C. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

## 1.11 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
    - b. Structural failures including plantings falling or blowing over.
    - c. Faulty performance of tree stabilization and tree grates.
    - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 2. Warranty Periods: From date of Substantial Completion.
    - a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
    - b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.
  - 3. Include the following remedial actions as a minimum:
    - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
    - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
    - c. A limit of one replacement of each plant is required except for losses or replacements due to failure to comply with requirements.

## PART 2 - PRODUCTS

### 2.1 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
  - 1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots are unacceptable.
  - 2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
- B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Landscape Architect, with a proportionate increase in size of roots or balls.
- C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.
- D. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.
- E. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.
- F. Annuals and Biennials: Provide healthy, disease-free plants of species and variety shown or listed, with well-established root systems reaching to sides of the container to maintain a firm ball, but not with excessive root growth encircling the container. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but not yet in bloom.

## 2.2 FERTILIZERS

- A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
  - 1. Size: 5-gram tablets.
  - 2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

## 2.3 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
  - 1. Type: Shredded hardwood.
  - 2. Size Range: 3 inches (76 mm) maximum, 1/2 inch (13 mm) minimum.
  - 3. Color: Natural.

## 2.4 FILTER FABRIC

- A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. (101g/sq. m) minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally encountered chemicals, alkalis, and acids.

## 2.5 PESTICIDES

- A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction. Pesticides only to be considered after non-chemical pest-control methods have been utilized without success.

## 2.6 TREE-STABILIZATION MATERIALS

- A. Tree Staples: Staple all trees 2 inches and greater in caliper and/or 6 feet greater in height, using Tree Staples brand uncoated, plain carbon steel staples (or equivalent) as per manufacturer's installation instructions. Follow table below for quantity and depth of staples required per tree:

Tree Caliper	Tree Staple Model	# Tree Staples Per Tree
1"-2"	TS24 (24")	2 with up to a 16" root ball
2"-4"	TS36 (36")	2 with up to a 24" root ball
4"-6"	TS42 (42")	3-4 with up to a 30" root ball
6-8"	TS48 (48")	3-4 with up to a 36" root ball

## 2.7 TREE GRATES

- A. Tree Grates: Ironsmith 4892F Metro Tree Grate, 17" Tree Opening (or equivalent)
- B. Shape and Size: As indicated on Drawings.
- C. Finish: Cast Aluminum.



## **2.8 MISCELLANEOUS PRODUCTS**

- A. Wood Pressure-Preservative Treatment: AWWA U1, Use Category UC4a; acceptable to authorities having jurisdiction, and containing no arsenic or chromium.
- B. Root Barrier: Black, molded, modular panels 24 inches (610 mm) high (deep), 85 mils (2.2 mm) thick, and with vertical root deflecting ribs protruding 3/4 inch (19 mm) out from panel surface; manufactured with minimum 50 percent recycled polyethylene plastic with UV inhibitors.
- C. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.
- D. Burlap: Non-synthetic, biodegradable.
- E. Planter Drainage Gravel: Washed, sound crushed stone or gravel complying with ASTM D448 for Size No. 8.
- F. Planter Filter Fabric: Nonwoven geotextile manufactured for separation applications and made of polypropylene, polyolefin, or polyester fibers or combination of them.
- G. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb (0.45 kg) of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb (0.45 kg) of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
  - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
  - 2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
  - 3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  - 4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Landscape Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

### **3.3 PLANTING AREA ESTABLISHMENT**

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Placing Planting Soil: Place and mix planting soil in-place over exposed subgrade.
- C. Before planting, obtain Landscape Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- D. Application of Mycorrhizal Fungi: At time directed by Landscape Architect, broadcast dry product uniformly over prepared soil at application rate according to manufacturer's written recommendations.

### **3.4 EXCAVATION FOR TREES AND SHRUBS**

- A. Planting Pits and Trenches: Excavate circular planting pits.
  - 1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
  - 2. Excavate approximately three times as wide as ball diameter for balled and burlapped stock.
  - 3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
  - 4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
  - 5. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
  - 6. Maintain supervision of excavations during working hours.
  - 7. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
- B. Backfill Soil: Subsoil and topsoil removed from excavations may be used as backfill soil unless otherwise indicated.
- C. Obstructions: Notify Landscape Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
  - 1. Hardpan Layer: Drill 6-inch- (150-mm-) diameter holes, 24 inches (600 mm) apart, into free-draining strata or to a depth of 10 feet (3 m), whichever is less, and backfill with free-draining material.
- D. Drainage: Notify Landscape Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

### **3.5 TREE, SHRUB, AND VINE PLANTING**

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above adjacent finish grades.
  - 1. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
  - 2. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  - 3. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
    - a. Quantity: Three for each caliper inch of plant.
  - 4. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above finish grades.
  - 1. Carefully remove root ball from container without damaging root ball or plant.
  - 2. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  - 3. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
    - a. Quantity: Three for each caliper inch of plant.
  - 4. Continue backfilling process. Water again after placing and tamping final layer of soil.
- E. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

### **3.6 MECHANIZED TREE-SPADE PLANTING**

- A. Trees may be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.
- B. Use the same tree spade to excavate the planting hole as will be used to extract and transport the tree.
- C. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.
- D. Cut exposed roots cleanly during transplanting operations.
- E. Plant trees following procedures in "Tree, Shrub, and Vine Planting" Article.
- F. Where possible, orient the tree in the same direction as in its original location.

### **3.7 TREE, SHRUB, AND VINE PRUNING**

- A. Remove only dead, dying, or broken branches. Do not prune for shape.

- B. Do not apply pruning paint to wounds.

### **3.8 TREE STABILIZATION**

- A. Root-Ball Stabilization: Install at- or below-grade stabilization system to secure each new planting by the root ball unless otherwise indicated.
  - 1. Proprietary Root-Ball Stabilization Device: Install root-ball stabilization system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

### **3.9 ROOT-BARRIER INSTALLATION**

- A. Install root barrier where trees are planted within 48 inches (1200 mm) of paving or other hardscape elements, such as walls, curbs, and walkways, unless otherwise indicated on Drawings.
- B. Align root barrier vertically or with bottom edge angled at 20 degrees away from the paving or other hardscape element and run it linearly along and adjacent to the paving or other hardscape elements to be protected from invasive roots.
- C. Install root barrier continuously for a distance of 60 inches (1500 mm) in each direction from the tree trunk, for a total distance of 10 feet (3 mm) per tree. If trees are spaced closer, use a single continuous piece of root barrier.
  - 1. Position top of root barrier flush with finish grade.
  - 2. Overlap root barrier a minimum of 12 inches (300 mm) at joints.
  - 3. Do not distort or bend root barrier during construction activities.
  - 4. Do not install root barrier surrounding the root ball of tree.

### **3.10 PLACING SOIL IN PLANTERS**

- A. Place a layer of drainage gravel at least 4 inches (100 mm) thick in bottom of planter. Cover bottom with filter fabric and wrap filter fabric 4 inches (100 mm) up on all sides. Duct tape along the entire top edge of the filter fabric, to secure the filter fabric against the sides during the soil-filling process.
- B. Fill planter with planting soil. Place soil in lightly compacted layers to an elevation of 1-1/2 inches (38 mm) below top of planter, allowing natural settlement.

### **3.11 GROUND COVER AND PLANT PLANTING**

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.
- B. Dig holes large enough to allow spreading of roots.
- C. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.
- D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

### **3.12 PLANTING AREA MULCHING**

- A. Mulch backfilled surfaces of planting areas and other areas indicated.
  - 1. Trees and Treelike Shrubs in Turf Areas: Apply organic mulch ring of 2-inch (50-mm) average thickness, with 24-inch (600-mm) radius around trunks or stems. Do not place mulch within 3 inches (75 mm) of trunks or stems.
  - 2. Organic Mulch in Planting Areas: Apply 2-inch (50-mm) average thickness of organic mulch extending 12 inches (300 mm) beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches (75 mm) of trunks or stems.

### **3.13 TREE GRATE INSTALLATION**

- A. Tree Grates: Install according to manufacturer's written instructions. Set grate segments flush with adjoining surfaces. Shim from supporting substrate with soil-resistant plastic. Maintain a 3-inch- (75-mm-) minimum growth radius around base of tree; break away portions of casting, if necessary, according to manufacturer's written instructions.

### **3.14 PLANT MAINTENANCE**

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

### **3.15 PESTICIDE APPLICATION**

- A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

### **3.16 REPAIR AND REPLACEMENT**

- A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Landscape Architect and Architect.
  - 1. Submit details of proposed pruning and repairs.
  - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
  - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.
- B. Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Landscape Architect determines are incapable of restoring to normal growth pattern.
  - 1. Provide new trees of same size as those being replaced for each tree of 6 inches (150 mm) or smaller in caliper size.
  - 2. Species of Replacement Trees: Species selected by Landscape Architect.

### **3.17 CLEANING AND PROTECTION**

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.
- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
- D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.
- E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.

### **3.18 MAINTENANCE SERVICE**

- A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
  - 1. Maintenance Period: 12 months from date of Substantial Completion.
- B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
  - 1. Maintenance Period: 12 months from date of Substantial Completion.

**END OF SECTION 32 93 00**

## SECTION 33 40 00 - STORM DRAINAGE UTILITIES

### PART 1 - GENERAL

#### 1.1 SCOPE OF WORK

Work under this section shall consist of providing all labor, plant facilities, materials, tools, equipment, shop drawings and supervision necessary and required to install all of the storm drainage facilities as specified in accordance with the Contract Documents. This work shall include but not be limited to:

- A. Installation of the drainage system consisting of manholes, catch basins, pipes, cleanouts, and all necessary and required accessory items and operations.

#### 1.2 RELATED SECTIONS AND DOCUMENTS

- A. Section 020187 – Protection of Existing Utilities
- B. Section 312333 – Soil Erosion and Sediment Control
- C. Local governing authority and code requirements.
- D. Contract Documents

#### 1.3 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM) latest edition.

A706	Type 1R
C14	Concrete Sewer, Storm Drain, and Culvert Pipe.
C76	Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
C443	Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.
C478	Precast Reinforced Concrete Manhole Sections.
C923	Resilient Connectors between Reinforced Concrete Manhole Structures and Pipes.
D1248	Polyethylene Plastic Molding and Extrusion Materials
D3350	Polyethylene Plastic Pipe and Fittings Materials
D1557	Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 10 lb (4.54 Kg) Rammer and 18 inch (457 mm) Drop.
D2922	Test Methods for Density of Soil and Soil - Aggregate in Place by Nuclear Methods (Shallow Depth).
D3017	Test Methods for Moisture Content of Soil and Soil-Aggregate Mixtures.

- B. American Association of State Highway and Transportation Officials (AASHTO) - latest edition

M36	Metallic (Zinc or Aluminum) Coated Corrugated Steel Culverts and Underdrains
M91	Standard Specification for Sewer and Manhole Brick
M-198	75I Type B
M294 and M252	Corrugated polyethylene pipe smooth interior

- C. International Masonry Industry All-Weather Council (IMIAC): Recommended Practices and Guide Specification for Cold Weather Masonry Construction.

#### **1.4 QUALITY ASSURANCE**

- A. An Engineer shall be retained to perform construction inspection on-site based on measurement, visual observation, and judgment.
- B. Visual field confirmation shall be performed by the Engineer as part of the construction testing requirements.
- C. All costs related to re-inspection due to failures shall be paid for by the Contractor at no additional expense to Owner. The Owner reserves the right to direct any inspection that is deemed necessary. Contractor shall provide free access to site for inspection activities.

#### **1.5 SUBMITTALS**

- A. Product Data: Provide manufacturer's certificate for castings, pipe and accessories to certify that products meet or exceed specified requirements.
- B. Submit shop drawings of the precast structures to the Engineer for approval prior to fabrication. Shop drawings shall include dimensions, reinforcing, joint treatment, invert elevations and invert locations.

#### **1.6 PROJECT RECORD DOCUMENTS**

- A. Accurately record actual locations of pipe runs, connections, catch basins, cleanouts, and invert elevations.
- B. Identify and describe unexpected variations to subsoil conditions and location of uncharted utilities.

#### **1.7 COORDINATION**

- A. Coordinate the Work with termination of storm sewer connection to existing storm sewer system.

### **PART 2 - PRODUCTS**

#### **2.1 SEWER PIPE MATERIALS AND ACCESSORIES**

- A. All round reinforced concrete pipe shall be Class III unless noted otherwise on the drawings per latest ASTM C76 specifications.

Note: Pipe shall be subject to rejection by the Engineer for failure to meet any of the Specification requirements or on account of any of the following:

- 1. Fractures of cracks passing through the shell, except that a single end crack that does not exceed the depth of the joint shall not be cause for rejection.
  - 2. Defects which indicate imperfect mixing and molding.
  - 3. Surface defects indicating honeycombed or open textures.
  - 4. Spalls deeper than 1/2 of the depth of the joint or extending more than 4 inches around the circumstances.
- B. Rubber gaskets for sealing of circular pipe shall conform to ASTM C443 requirements



## 2.2 CATCH BASINS, INLETS, MANHOLES AND COMPONENTS

- A. General: All manholes, catch basins and drain inlets shall be built in accordance with, and in the locations shown on the Contract Documents. All structures will require shop drawings approved by the Engineer.

No concrete or masonry shall be placed when the temperature is below 40 degrees Fahrenheit, or when indications are for lower temperatures within 24 hours, unless protection of concrete and masonry is approved by the Engineer. Damage to the structure because of freezing shall be corrected by the Contractor at his own expense, to the satisfaction of the Engineer.

Manholes, catch basins and drain inlets shall be constructed as soon as the pipe laying reaches the location of the structures. Any structure which is located or oriented improperly shall be removed and re-built in its proper location, alignment and orientation at the Contractor's expense.

- B. Precast Concrete Manholes: AASHTO M199-93/ASTM C478-90b. Manhole diameter shall be selected to accommodate the inflow and outflow pipes.

Pour-in-place or Precast Reinforced Concrete Catch Basins: AASHTO M199-93/ASTM C478-90b rated for H20 loading, with minimum concrete strength of 4,500 psi. Inlet size shall be selected to accommodate the inflow and outflow pipes.

1. Manhole Barrel: Reinforced precast concrete in accordance with ASTM C478 with gaskets in accordance with ASTM C923.
  - a. Construct manholes of precast concrete sections as required by Contract Documents to size, shape, and depth indicated, but never less than 4 feet inside diameter.
2. Mortar and Grout: Mortar for finishing and sealing shall be Class "C". Honeycombing less than 2 inches deep shall be repaired using Class "D" mortar.
3. Brick Transition Reinforcement: Formed 8 gauge steel wire with galvanized finish.
4. Foundations: All foundations shall rest on firm soil of uniform bearing and stone subbase as shown on Contract Documents.
5. Inverts: Brick or smooth concrete invert channels shall be constructed in all manholes and in all catch basins and drain inlets which do not have sumps, to insure a smooth flow of water through the structure. The invert channel shall be constructed to the elevations shown on the Contract Documents and/or as approved by the Engineer. Channels shall slope smoothly and evenly from the entrance pipe to the outlet pipe.
6. Frames, Cover, and Gratings: Frames, Covers and/or gratings for manholes, catch basins, and drain inlets shall be of the type and size indicated on the Contract Documents. Frames shall be well bedded in mortar and shall be set accurately to the correct alignment and grade.
7. Ladder Rungs: Forged Aluminum to dimensions shown on Contract Documents.
8. Precast Structures: Precast structures shall be installed only after shop drawings have been approved by the Engineer and shall meet the requirements of ASTM C478.

Grout around pipes which protrude through the walls of the structure and on all joints shall contain "Antihydro", or other approved additive to insure water tightness. Cement grout shall contain two parts cement to one-part sand and additive in accordance with manufacturer's recommendations. Mortar shall be applied to the bottom 1/3 of the opening before the pipe is inserted.

The top grade of the precast concrete corbel section shall be set sufficiently below finished grade to permit a maximum of 7 and a minimum of 2 courses of 8-inch brick to be used as risers to adjust the grade of the casting. Manhole frames shall be set on a grout pad as specified herein above.

9. Provide precast manhole shaft construction with eccentric cone top section and lipped male/female rubber gasket joints or mortar joints.
10. Brick shall be new units conforming to AASHTO Designation M-91, latest revision, Grade MS.
11. Mortar shall conform to ASTM C270, Type M.
12. Pipe joints for rigid pipes shall be made with mortar, grout, gaskets, or as recommended by the pipe manufacturer.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify that trench cut and excavation is ready to receive work and excavations, dimensions, and elevations are as indicated on Contract Documents.

#### **3.2 PREPARATION**

- A. Hand-trim excavations to required elevations. Correct over-excavation with fine aggregate.
- B. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.
- C. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If marker needs to be removed it shall be referenced by licensed land surveyor and replaced, as necessary, by same.

#### **3.3 GENERAL**

- A. The Contractor shall install all drainage structures and pipe in the locations shown on the Contract Documents and/or as approved by the Engineer. Pipe shall be of the type and sizes specified and shall be laid accurately to line and grade. Structures shall be accurately located and properly oriented.
- B. Excavation and backfill shall be in accordance with Section 312333 of these specifications.
- C. Storage and Handling of Pipe - All pipe shall be protected against impact, shock and free fall, and only equipment of sufficient capacity and proper design shall be used in the handling of the pipe. Storage of pipe on the job shall be in accordance with the pipe manufacturer's recommendations.
- D. Damage to Pipe - Pipe which is defective from any cause, including damage caused by handling, and determined by the Engineer as unrepairable, shall be unacceptable for installation and shall be replaced at no cost to the Owner as directed by the Engineer. Pipe that is damaged or disturbed through any cause prior to acceptance of the Work, shall be repaired, realigned or replaced as directed by the Engineer, at the Contractor's expense.

#### **3.4 BEDDING**

- A. Excavate pipe trench and place bedding material in accordance with specifications

### **3.5 INSTALLATION - PIPE**

- A. Laying Pipe: Each length of pipe shall be laid with firm, full and even bearing throughout the entire length, in a trench prepared and maintained in accordance with the Contract Documents. Pipe shall be laid upgrade unless otherwise approved by the Engineer. Every length of pipe shall be inspected and cleaned of all dirt and debris before being laid. Prior to placing a length of pipe, the end of the previously laid length shall be carefully and thoroughly wiped smooth and clean to obtain an even and close-fitting joint. No length of pipe shall be laid until the preceding lengths of pipe have been thoroughly embedded in place, so as to prevent movement or disturbance of the pipe.
- B. Place pipe on minimum 6-inch-thick bed of compacted bedding or as detailed on the Contract Documents.
- C. Install pipe, fittings, and accessories in accordance with manufacturer's instructions and/or state or local requirements. Seal joints to be watertight.
- D. Lay pipe to slope gradients noted on Contract Documents with maximum variation from true slope of 1/8 inch in 10 feet.
- E. Place and compact bedding aggregate at sides and to the springline of the pipe as per these Specifications.
- F. Refer to the specifications for backfill requirements. Do not displace or damage pipe when compacting.
- G. Full Lengths of Pipe: Only full lengths of pipe shall be used in the installation except that partial lengths of pipe may be used at the entrance to structures where necessary to obtain a proper connection to the structure.
- H. Pipe Entrances to Structures: All pipe entering structures (e.g.: manholes, catch basins, etc.) shall be cut flush with the inside of the structure, and the cut ends of the pipe and surface of the structure shall be properly rounded and finished so that there will be no protrusion, ragged edges, or imperfections that will impede the flow of water or affect the hydraulic characteristics of the installation. Only full sections of pipe shall be used where entering a structure which will be exposed to view, such as endwalls, headwalls, end sections, etc.
- I. Bedding and Backfilling: The type of materials to be used in bedding and backfilling and the method and placement shall conform to the requirements of these Specifications.
- J. Protection During Construction: The Contractor shall protect the installation at all times during construction, and movement of construction equipment, vehicles and loads over and or adjacent to any pipe shall be performed at the Contractor's risk.
- K. Tolerance: Pipe shall be laid accurately to the line and grade shown on the Contract Documents and/or as approved by the Engineer. Allowable tolerances shall be 1/2 inch on grade and 1 inch on line in any section of pipe between structures. Deviations from these tolerances shall be a basis for rejection of the line of pipe by the Engineer. Any line which has been rejected shall be rebuilt to correct line and grade by the Contractor at his own expense.

### **3.6 INSTALLATION - CATCH BASINS, MANHOLES AND CONTROL STRUCTURES**

- A. Form bottom of excavation clean and smooth to correct elevation.
- B. Form and place cast-in-place concrete base pad, with provision for storm sewer pipe to be placed at proper elevation.

- C. Place precast reinforced concrete sections with provision for storm sewer pipe sections at the location and elevation specified on the Contract Documents.
- D. Level top surface of each precast concrete shaft sections as assembly progresses.
- E. Establish elevations and pipe inverts for inlets and outlets as indicated.
- F. Lay brick masonry in running bond with full 3/8-inch mortar joints to receive casting assembly. Level casting frame in grout to receive grated inlet or manhole cover.

### **3.7 PLACING PRE-CAST MANHOLE BARREL SECTIONS**

- A. Place base pad to proper elevation and location and trowel top surface level for placement of manhole barrel.
- B. Place manhole barrel plumb and level to correct elevations and anchor to base pad.
  - 1. After completion of slab foundation, the first joint of manhole barrel shall be lowered into position, grooved end first, and set level and plumb on concrete base. Align and adjust to proper grade prior to placing and forming invert which shall be poured immediately after setting of first section of manhole barrel.
  - 2. Prior to setting subsequent manhole barrel sections, apply primer to tongue and groove ends and allow to set in accordance with manufacturer recommendations. Place "Ram-nek", or equivalent, plastic rope on tongue end. Lower next section into position, and remove excess material from interior of structure. Add additional material on exterior of joint, if necessary, for completely watertight joint.

### **3.8 INTERFACE WITH EXISTING FACILITIES**

- A. Requirements: The Contractor shall make all required connections of the proposed drainage facilities into existing drainage facilities, where and as shown on the Contract Documents and/or as approved by the Engineer.
- B. Compliance with Facility Owner Requirements: Connections made into existing drainage facilities shall be performed in accordance with the requirements of the Owner of the facility. The Contractor will be required to comply with all such requirements, including securing of all required permits, and paying the costs thereof. The cost of making the connections in accordance with the requirements of the Owner of the existing facility shall be included in the Contract Sum.

### **3.9 REMOVAL OF EXISTING UTILITIES**

- A. The Contractor shall remove and legally dispose of off-site all abandoned utilities encountered during installation of the storm drainage facilities. In particular, all components of the existing combined sewer shall be removed from the site and up to the nearest off-site manhole.

### **3.10 MODIFICATIONS TO EXISTING STRUCTURES**

- A. General: The Contractor shall alter, reconstruct and/or convert existing structures where and as shown on the Contract Documents, and/or as approved by the Engineer. In general, alterations shall be performed with the same type of material used in the original construction unless otherwise indicated on the Contract Documents or approved by the Engineer.
- C. Damage to Existing Installations: The Contractor shall exercise extreme care during such alteration, reconstruction and/or conversions so as not to damage any portions of the structure and/or pipe shown to remain. Any such damage shall be repaired by the Contractor at his own expense and to the satisfaction of the Engineer and Owner of the damaged structure.

### **3.11 CLEANING AND REPAIR**

- A. The Contractor will be required to clean the entire drainage system of all debris and obstructions. This shall include, but not be limited to, removal of all formwork from structures, concrete and mortar droppings, construction debris and dirt. The system shall be thoroughly flushed clean and the Contractor shall furnish all necessary hose, pumps, pipe and other equipment that may be required for this purpose. No debris shall be flushed into existing storm drains or streams; all debris shall be removed from the system and disposed of in accordance with all governing agencies.
- B. After the system has been cleaned, the Contractor shall thoroughly inspect the system along with the Engineer and all repairs shown to be necessary shall be promptly made by the Contractor.
- C. All Work of cleaning and repair as specified herein shall be performed at the Contractor's expense and to the complete satisfaction of the Engineer.

### **3.12 FINAL INSPECTION**

Upon completion of the Work and before final acceptance by the Owner, the entire drainage system shall be subject to a final inspection in the presence of the Engineer. The Work shall not be considered as complete until all requirements for line, grade, cleanliness, and workmanship have been completed to the satisfaction of the Engineer.

### **END OF SECTION 33 40 00**

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