

**Project Manual  
For  
FAA FIS Hangar Rehabilitation  
W. K. Kellogg Airport  
Battle Creek, Michigan**

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3141900-160242.01

*Prepared for:*

**W. K. Kellogg Airport  
Battle Creek, Michigan**

*Prepared by:*



**Bid Set**

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## **SECTION 007213 –CONDITIONS OF THE CONTRACT**

### **PART 1 - GENERAL**

#### **1.1 GENERAL CONDITIONS**

- A. The General Conditions for the Project are as follows:
1. AIA Document A201, "General Conditions of the Contract for Construction" are incorporated by reference.
  2. Copies of AIA standard forms may be obtained from the American Institute of Architects; <http://www.aia.org/contractdocs/purchase/index.htm>; [docspurchases@aia.org](mailto:docspurchases@aia.org); (800) 942-7732.
- B. These conditions are in addition to the contract requirements of the City of Battle Creek. In the event of any discrepancy between the requirements of AIA Document 201 and those of the City of Battle Creek, those of the City of Battle Creek shall take precedence.

#### **1.2 SUPPLEMENTARY CONDITIONS**

- A. The Contractor and his surety shall indemnify and save harmless the consultant or project engineer and the Owner and their officers, and employees, from all suits, actions, or claims of any character brought because of any injuries or damage received or sustained by any person, persons, or property on account of the operations of the Contractor; or on account of or in consequence of any neglect in safeguarding the work; or through use of unacceptable materials in constructing the work; or because of any act or omission, neglect, or misconduct of said Contractor; or because of any claims or amounts recovered from any infringements of patent, trademark, or copyright; or from any claims or amounts arising or recovered under the "Workmen's Compensation Act," or any other law, ordinance, order, or decree. Money due the Contractor under and by virtue of his contract as may be considered necessary by the Owner for such purpose may be retained for the use of the Owner or, in case no money is due, his surety may be held until such suit or suits, action or actions, claim or claims for injuries or damages as aforesaid shall have been settled and suitable evidence to that effect furnished to the Owner and its agent, except that money due the Contractor will not be withheld when the Contractor had produced satisfactory evidence that he is adequately protected by public liability and property damage insurance to limits established by the Owner.

### **PART 2 - PRODUCTS (Not Used)**

### **PART 3 - EXECUTION (Not Used)**

**END OF DOCUMENT 007213**

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## **SECTION 011000 – SUMMARY OF THE WORK**

### **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. Work Included.
  2. Phased construction and Work Scheduling
  3. Work under separate contracts.
  4. Contract Scope Delineations/Clarifications
  5. Access to site.
  6. Coordination with occupants.
  7. Work restrictions.
  8. General Specification Requirements

#### **1.3 WORK INCLUDED**

- A. The Work of the Contract is to perform various repairs and upgrades to the existing facility and site as described generally herein and further defined in the Contract Documents. Work includes specific primary work items identified by "WI-###" reference numbers herein as well as all other related general and incidental work indicated in the contract documents or otherwise necessary to complete the work noted. These Work Items are included in the base bid or in alternate bid items as scheduled in Section 012300-Base and Alternate Bid Items.

1. Work Item WI-1: Upgrade Fire Protection System in Avionics Area as indicated.
2. Work Item WI-2: Remove fire suppression system hose stations and related piping as indicated.
3. Work Item WI-3: Provide ADA upgrades as follows:
  - a. Provide low headroom barrier rails in Stair 1.
  - b. Provide low headroom barrier rails in Stair 2.
  - c. Provide detectable height cabinet below AED in Open Office 222.
4. Work Item WI-4: Remove and replace Storage Shed floor as detailed.
5. Work Item WI-5: Replace overhead light fixtures and modify related circuits and controls in Hangar 131.
6. Work Item WI-6: Replace pendant light fixtures and modify related circuits and controls in Open Office 222.

7. Work Item WI-7: Install Occupancy sensors to control existing light fixtures in first and second floor rooms as indicated. (Note: New occupancy sensors for Open Office 222 are included in Work Item WI-6)
8. Work Item WI-8: Replace all existing exit signs with LED-type exit signs.
9. Work Item WI-9: Retrofit all pole-mounted parking light fixture heads with LED.
10. Work Item WI-10: Replace all existing walkway bollard lights with LED bollards, including foundations as necessary.
11. Work Item WI-11: Provide control system to interlock infra-red heaters in Hangar 131 with Hangar Door position.
12. Work Item WI-12: Replace existing boiler with 2 high-efficiency boilers and associated system components.
13. Work Item WI-13: Provide additional hot water unit heater at ceiling of Supply Room 129.
14. Work Item WI-14: Provide a new ductless split air conditioning system to provide cooling for Equipment Closet 206.
  - a. Modify and adjust existing controls to allow existing AHU to go to unoccupied modes.
15. Work Item WI-15: Replace existing ceiling destratification fans and controls in Hangar 131.
16. Work Item WI-16: Repair partially collapsed main return air duct above HVAC equipment in Mechanical/Electrical Room 130.
17. Work Item WI-17: Provide soffit, extend ducts, replace grills and repair finishes in Vestibule 101.
18. Work Item WI-18: Replace plumbing fixtures as follows:
  - a. Toilet and urinal flush valves and associated components (Toilet Rooms 105, 107, 204 & 205).
  - b. Lavatory sink faucets (Toilet Rooms 105, 107, 204 & 205).
  - c. Service Sink faucets (Janitor Rooms 108 and 203).
  - d. Utility Sink faucet (Battery Room 126).
  - e. Electric Water Coolers (Corridor 110 and Open Office 222).
  - f. Domestic Hot Water Heater (Mechanical Room).
19. Work Item WI-19: Provide new room finishes as indicated on Room Finish Schedule.
  - a. Rooms 102, 110, 117 & 121
  - b. Rooms 115 & 116
  - c. Room 131 (Hangar)

- d. Rooms 201 through 222: Floor and base
  - e. Rooms 201 through 222: Walls, door frames & window frames
  - f. Stair 1 & Stair 2
  - g. Note: Room 109 is included in WI-21.
20. Work Item WI-20: Replace upper hanger clips with beam clamps for all suspended acoustical tile ceiling systems on second floor as indicated on the Room Finish Schedule.
21. Work Item WI-21: Remove recessed floor grate, infill recess and provide new floor finish in Vestibule 109.
22. Work Item WI-22: Re-secure all sagging roof insulation in Hangar 131.
23. Work Item WI-23: Replace window shades on exterior windows of Rooms 220, 221, and 222.
24. Work Item WI-24: Replace kitchenette cabinets, countertop and sink in Breakroom 116.
25. Work Item WI-25: Remove and replace interior caulking as indicated:
- a. Around exterior windows on second floor (Rooms 220, 221 & 222).
  - b. Around all toilets, urinals and lavatories (Rooms 105, 107, 204 & 205).
  - c. Around mop sinks (Janitor Rooms 108 & 203) and utility sinks (Room 126 & 131).
26. Work Item WI-26: Provide stainless steel splash guards on walls at mop sinks in Janitor Rooms 108 & 203.
27. Work Item WI-27: Repair and improve exterior wall flashings and sealants on exterior of main building.
- a. Remove portions of previous flashings as noted, repair and secure existing flashings and provide new flashings and seals at all upper and lower reveals on west, south and east walls per details.
  - b. Replace and seal all vertical IMP butt-joint covers per details.
  - c. Reseal all exterior wall penetrations, and wall-mounted objects.
  - d. Resecure loose flashings, straighten bent flashings, and seal joints and fastener holes in existing metal flashings.
  - e. Remove and replace sealants on exterior side of all joints in all aluminum window frames. Reseal all gaps in window glazing sealant.
  - f. Remove and replace sealants at perimeters of all aluminum window frames.
  - g. Reseal ends of all window sill flashings at jambs.
  - h. Install flashing and seals below second floor window sill flashing, per details.
  - i. Provide membrane flashing and prefinished metal covers at all lap joints in existing window sill flashings.
  - j. Reseal all door drip caps to wall surfaces.

- k. Provide additional weep holes in bottom of all existing metal U-trim at bottom of all insulated wall panels (above reveals, etc.)
- 28. Work Item WI-28: Clean, prepare and refinish all exterior masonry surfaces and exposed steel lintels, with specified coating systems.
- 29. Work Item WI-29: Remove and replace sealant and backer rods in all exterior masonry control joints.
- 30. Work Item WI-30: Replace metal roof curbs for 4 rooftop exhaust fans.
- 31. Work Item WI-31: Replace roof gutters and downspouts as indicated.
- 32. Work Item WI-32: Replace 8 exterior hangar intake hoods per details.
- 33. Work Item WI-33: Replace awning fabric at employee entrance.
- 34. Work Item WI-34: Replace 4 fogged insulated glass units in hangar door windows.
- 35. Work Item WI-35: Replace seals at bottom of sliding hangar door.
- 36. Work Item WI-36: Provide bird spikes at top of hangar doors.
- 37. Work Item WI-37: Repaint exterior hangar rods above main entry awning.
- 38. Work Item WI-38: Replace doors, frames and hardware as indicated on the drawings and schedules, including:
  - a. 5 Interior Fire-Rated pass doors, frames and hardware. Paint to match existing.
  - b. 8 Exterior hollow metal pass doors, frames and hardware. Paint to match existing.
  - c. Replace seals and add threshold for exterior overhead door 131C.
- 39. Work Item WI-39: Replace existing exterior drainage trenches along east and west walls, as indicated.
- 40. Work Item WI-40: Regrade site and reestablish turf and new gravel surfacing south of the main building as indicated.
- 41. Work Item WI-41: Regrade site and reestablish turf and new gravel surfacing west of the main building and driveway as indicated, including:
- 42. Work Item WI-42: Repair damaged foundation insulation and provide new gravel maintenance strip on south and west sides of FAA equipment storage building.
- 43. Work Item WI-43: Remove and replace pavement joint sealants and backer rods on hanger aircraft apron and connector to Taxiway B.

44. Work Item WI-44: Remove and replace west driveway pavement, base courses and subgrade, including portion of concrete apron at Storage Building, and new concrete dumpster pad as indicated.
45. Work Item WI-45: Provide snow melt system at apron outside of hangar door, including:
  - a. Complete boiler systems and related piping, manifolds, under-slab tubing, gas supply, and all related components and incidental work.
  - b. Removal and replacement of concrete apron slabs to install insulation and tubing and to provide thickened edges adjacent to heated portions.
  - c. New covers for exposed exterior tubing at walls.
  - d. New bollards adjacent to new tubing covers.
46. All work:
  - a. Field verify existing conditions pertinent to the work prior to submitting a bid, and prior to ordering or fabricating materials.
  - b. Protect Owner's/Tenant's furnishings from damage during the work.
  - c. Coordinate and sequence work to minimize disruption to facility operations and comply with security protocols.
  - d. Provide passive and active measures as needed to contain dust, noise, fumes odors and debris to the immediate work area.
  - e. Provide all other work indicated and incidentally necessary to complete the work in the Contract Documents to meet specified requirements, applicable codes and industry standards, complete, ready-to-use and with top-quality workmanship, including related mobilization, demobilization, badging/escorts/security measures, temporary provisions, demolition, modifications to other systems, restoration of disturbed work, finishes, permits/fees, quality control, coordination, equipment, etc. Cost for each work item shall include all related incidental work necessary to complete it.
47. The work will be completed under a single prime contract.
  - a. Bidders:
    - 1) Provide pricing for base bid and all alternate bid items as indicated in Section 012300-Base and Alternate Bid Items.
  - b. Selected Contractor:
    - 1) Provide a schedule of values listing the total cost for each individual Work Item (WI-#) included in both the Base Bid and each Alternate Bid selected by the Owner, in accordance with Section 012900-Payment Procedures, to be used for assessing progress and progress payments.
      - a) Provide a breakdown of primary components/trades within each Work Item.

- b) Submit for review and approval and incorporate revisions as directed prior to submitting first partial pay application.

#### 1.4 PHASED CONSTRUCTION AND WORK SCHEDULING

- A. The Work of this Contract shall be conducted in overall phases and contract times indicated on the Construction Safety Phasing Plan (Drawing G-050) and as further indicated herein.
- B. Building improvements under each phase shall be done in sub-phases developed by the Contractor and approved by the Owner and FAA as needed to maintain ongoing facility operations and meet security requirements of the FAA.
- C. Sub-phases shall incorporate and account for:
  - 1. All individual Work Items included in the scope of work.
  - 2. Work Items that require sub-phases to temporarily relocate operations, staff, furniture and equipment and/or to temporarily vacate spaces to accomplish the work in portions.
    - a. General Parameters (unless otherwise approved):
      - 1) All work within an individual office shall be accomplished at one time, and sequenced to permit temporary relocation of staff to other office spaces.
      - 2) All work within the 2<sup>nd</sup> floor open office area shall be accomplished in sub-phases to permit temporary relocation of staff, temporary relocation and storage of furniture, maintenance of exit access, movement of materials, and provision of temporary partitions to protect adjacent areas. All work within a sub-phase area shall be accomplished at one time.
      - 3) Sub-phases shall take in to account the need for Contractor's badged escorts to be present with all contractor workmen/personnel at all times when they are within the secure site and building.
      - 4) Avionics Shop: Work shall be scheduled during periods of low or no activity as determined by the FAA, typically Wednesdays and Thursdays, to maintain normal support capabilities for aircraft equipment.
      - 5) Hangar: All work in or above the interior of the Hangar Bay shall be completed before or after the work on the exterior apron to allow for aircraft parking at all times.
      - 6) Apron: Apron replacement and apron joint sealing work shall be done in 2 sub-phases (2 halves centered on hangar) to allow full access to either half of the hangar door at all times.
      - 7) Other areas: As coordinated with the FAA.
- D. Before commencing Work, Contractor shall prepare and submit a proposed construction phasing schedule showing the sequence, commencement and completion dates, and work items related to the various phases and proposed subphases of the Work for review by the Owner and the tenant (FAA). Contractor shall incorporate changes as

directed/needed to accommodate continuous FAA operations throughout the work period.

#### 1.5 WORK UNDER SEPARATE CONTRACTS

- A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract or other contracts. Coordinate the Work of this Contract with work performed under separate contracts.
- B. Work by others: Owner anticipates awarding separate contracts for the following work and services at the Project site which may occur within this project timeframe:
  - 1. Electrical Distribution System Testing
  - 2. Landscaping and Plantings

#### 1.6 CONTRACT SCOPE DELINEATIONS/CLARIFICATIONS

- A. Responsibility for moving and temporary removal/storage of furniture and furnishings as needed to complete the work shall be as follows:
  - 1. Staff/personal items: (e.g.: personal items in office spaces): By FAA.
  - 2. Office furniture (e.g.: non-fixed desks, tables, shelving units, chairs, etc.): By Contractor.
  - 3. File storage systems (e.g.: file cabinets, etc.): By Contractor.
  - 4. Systems furniture (e.g.: cubicles and accessories in Room 222, etc.): By Contractor.
  - 5. Office electronic/equipment: (e.g.: computers/monitors, printers, copiers, telephones, associated cabling, etc.): By Contractor unless otherwise determined by FAA.
  - 6. Wall hangings: (e.g.: framed/unframed items, clocks, décor, etc.): By Contractor.
  - 7. Mounted furnishings: (e.g.: shelving/brackets, tack/marker boards, etc.): By Contractor.
  - 8. Mounted electronics/equipment: (e.g.: flat screen monitors, smart boards, etc.): By Contractor.
  - 9. Non-fixed/non-piped workbenches and equipment in Hangar Bay.
  - 10. Stored Materials and racks in Hazardous Materials shed west of hangar, etc.: By FAA.
  - 11. Other items: (as needed): By Contractor.
- B. Temporary relocation of existing FF&E shall include:
  - 1. Recording any existing damage before relocation.
  - 2. Tagging/logging items and components to reassemble and reposition them after completion of the work.
  - 3. Disassembly as required for moving; and bagging and tagging hardware to prevent loss.
  - 4. Temporary relocation
  - 5. Protection against damage
  - 6. Reassembly in original positions.
  - 7. Cleaning/repair of any damage from temporary relocation.

## 1.7 OWNER-FURNISHED PRODUCTS

- A. The Work includes receipt, storage, protection and installation of certain items to be furnished by the Owner to the project site.
1. Item to be furnished by the Owner:
    - a. None unless specifically noted in the contract documents.

## 1.8 ACCESS TO SITE

- A. General: Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Project Boundaries, and as indicated by requirements of this Section.
- B. Use of Site: Limit use of Project site to areas within the Project Boundaries indicated on the Construction Safety Phasing Plan (Drawing G-050). Do not disturb portions of Project site beyond areas in which the Work is indicated.
1. Limits: Confine construction activities and storage and staging to areas designated on the Construction Safety Phasing Plan (Drawing G-050).
  2. Limits: Limit site disturbance, including earthwork to 10 feet beyond extents of new work indicated unless otherwise approved.
  3. Driveways, Walkways and Entrances: Keep driveways and entrances serving premises clear and available to Owner, Owner's employees, Tenants (FAA) and emergency vehicles at all times. Do not use these areas for parking or storage of materials.
    - a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
    - b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

## 1.9 COORDINATION WITH OCCUPANTS

- A. Full Tenant Occupancy: Tenant (FAA) will occupy the existing building and other airport facilities during the entire construction period. Cooperate with Tenant during construction operations to minimize conflicts and facilitate Tenant usage. Perform the Work so as to accommodate Tenant's ongoing day-to-day operations.
1. Maintain access to existing facilities. Do not close or obstruct access to occupied or used facilities without written permission from Tenant.
  2. Notify Tenant not less than 72 hours in advance of activities that will affect Tenant's operations.
  3. Coordinate final sequencing of phased work with tenant.
  4. Local FAA personnel will cooperate as much as possible, but construction must not prevent ongoing activities.
  5. Current occupant load (approximately 22) will allow flexibility of phased temporary moves in office/breakroom/hallway areas to complete the work.



6. The addition of cooling equipment for the second-floor equipment room (east end) are not expected to require any server shutdowns. Servers are owned/operated by other FAA groups (not local FAA).
  7. Avionics workshop is typically not in use on Wednesdays or Thursdays, which should allow fire protection modifications and other work in those rooms.
  8. FAA can move aircraft out of hangar as needed during overhead work, media blasting, painting, and other work in the hangar bay.
- B. Tenant Limited Occupancy of Completed Areas of Construction: Tenant reserves the right to place and install furnishings and equipment in completed portions of the Work, prior to Substantial Completion of all of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.

#### 1.10 WORK RESTRICTIONS

- A. Work Restrictions, General: Comply with restrictions on construction operations as indicated.
1. Comply with limitations on use of public streets and with other requirements of authorities having jurisdiction.
  2. Comply with all requirements and restrictions noted on the Construction Safety Phasing Plan (Drawing G-050).
- B. On-Site Work Hours: Limit work on site and in the existing building to normal business working hours of 7:00 a.m. to 5:00 p.m., Monday through Friday during which tenants will be present, unless otherwise indicated.
1. After Hours/Weekend Hours: No work shall be allowed after normal business working hours or on weekends.
  2. Early Morning Hours: Comply with regulations by authorities having jurisdiction for restrictions on noisy work.
  3. Hours for Utility Shutdowns: Coordinate with Tenant to perform shutdowns at times to avoid disruption of normal facility operations, and to minimize impact and lengths of unavoidable outages.
  4. Hours for crane and high-lift operation: Comply with restrictions noted on the Construction Safety Phasing Plan (Drawing G-050).
- C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after providing temporary utility services according to requirements indicated:
1. Notify Tenant not less than two 2 days in advance of proposed utility interruptions.
  2. Obtain Tenant's written permission before proceeding with utility interruptions.
- D. Noise, Vibration, and Odors: Coordinate operations that may result in high levels of noise and vibration, odors, or other disruption to Tenant occupancy with Tenant.
1. Notify Tenant not less than two 2 days in advance of proposed disruptive operations.

2. Obtain Tenant's written permission before proceeding with disruptive operations.
- E. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet of entrances, operable windows, or outdoor-air intakes.
  - F. Controlled Substances: Use of tobacco products and other controlled substances on Project site is not permitted.
  - G. Employee Identification: Contractor shall provide identification tags for all Contractor personnel working on Project site in accordance with FAA Security requirements. Require all personnel to use identification tags at all times.
  - H. Employee Screening: Comply with Owner's and FAA's requirements for screening of Contractor personnel working on Project site.
    1. Maintain list of approved screened personnel with Tenant's representative.

#### 1.11 GENERAL SPECIFICATION REQUIREMENTS

- A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:
  1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
  2. Specification requirements are to be performed by Contractor unless specifically stated otherwise.
- B. Division 01 General Requirements: Requirements of Sections in Division 01 apply to all Work and the Work under all Sections in the Specifications.

#### **PART 2 - PRODUCTS (Not Used)**

#### **PART 3 - EXECUTION (Not Used)**

#### **END OF SECTION 011000**

## **SECTION 012300 – BASE AND ALTERNATE BID ITEMS**

### **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.
- B. All work shall comply with pertinent requirements of the drawings and project specifications.

#### **1.2 SUMMARY**

- A. Section includes the scope of work and procedural requirements for Base Bid and Alternate Bids listed in the Bid Form.
- B. Work Items included in the Base Bid and in each Alternate Bid are listed in the Base Bid and Alternate Bid Schedule following this section.
- C. Numbers, titles and descriptions of Work Items (WI-##) are abbreviated for reference and do not necessarily describe the entire extent of materials and procedures required to complete the associated work.
- D. Each Bidder shall carefully read descriptions herein and in Section 011000 “Summary of the Work”, and shall examine all Contract Documents to determine the extent of work required for each Work Item included in the Base Bid and each Alternate Bid.
- E. Include any applicable modifications made by addendum.

#### **1.3 DEFINITIONS**

- A. Base Bid: An amount proposed by bidders and stated on the Bid Form to complete the Work Items listed to be part of the Base Bid in the attached schedule.
  - 1. The cost for the Base Bid is the net total base project Contract Sum to complete the stated Work Items, including all associated labor, materials, equipment, fees, procedures, insurance, bonds, overhead and profit and incidental work.
- B. Alternates Bids (AB#): An amount proposed by bidders and stated on the Bid Form to be added to the Base Bid amount to complete the Work Items listed for each Alternate Bid in the attached schedule.
  - 1. The cost for each Alternate Bid Item is the net addition to the Contract Sum to fully incorporate the alternate into the Work including all labor, materials, equipment, fees, procedures, insurance, bonds, overhead and profit and incidental work. No other adjustments will be made to the Contract Sum for work under Alternate Bids.
  - 2. Alternate Bids described in this Section are part of the work only if enumerated in the Agreement.

3. Alternate Bids may be incorporated individually or in any combination with the Base Bid, at the Owner's discretion.

#### 1.4 PROCEDURES

- A. Coordination: Revise or adjust affected adjacent work as necessary to completely integrate work of the Base Bid and Alternate Bids into Project.
  1. Include miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation whether or not specifically indicated as part of the Base Bid or Alternate Bid.
  2. It is the responsibility of each Bidder to make certain that the Bidder, and all subcontractors and material suppliers understand the scope of the Base Bid and each Alternate Bid, and to coordinate various additions, deletions, and substitutions in such manner that costs for the Base Bid and each Alternate Bid take into account all items affected, including additional work in any one trade made necessary by additions, deductions, or substitutions in another. Consideration will not be given to any claim for extra money arising from any Bidder's failure to properly exercise this responsibility.
  3. Base Bid and Alternate Bids shall include their proper share of taxes, insurance, bonds, overhead and profit.
- B. Notification:
  1. Base Bid and Alternate Bids quoted on the bid form will be reviewed and accepted or rejected in any combination at the Owner's option.
  2. Immediately following award of the Contract, Owner will notify contractor, in writing, to indicate which Alternate Bid Items have been accepted.
  3. Execute accepted Alternate Bids under the same conditions as other work of the Contract.
  4. Changes in the work resulting from acceptance of Alternate Bids are to be complete for the portion of the work affected, whether or not references are so noted in description of each Alternate Bids.

### **PART 2 - PRODUCTS (Not Used)**

### **PART 3 - EXECUTION**

#### 3.1 BASE BID AND ALTERNATE BID SCHEDULE

- A. See schedule immediately following this section.

**END OF SECTION 012300**



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## **SECTION 012500 - SUBSTITUTION PROCEDURES**

### **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 administrative and procedural requirements for substitutions.
- B. Related Requirements:
  - 1. Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.

#### **1.3 DEFINITIONS**

- A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.
  - 1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
  - 2. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.

#### **1.4 SUBMITTALS**

- A. Substitution Requests: Submit three copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - 1. Substitution Request Form: Use CSI Form 13.1A.
  - 2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
    - b. Coordination information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Owner and separate contractors that will be necessary to accommodate proposed substitution.
    - c. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, sustainable design

- characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
- d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
  - e. Samples, where applicable or requested.
  - f. Certificates and qualification data, where applicable or requested.
  - g. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners.
  - h. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
  - i. Research reports evidencing compliance with building code in effect for Project, from ICC-ES.
  - j. Detailed comparison of Contractor's construction schedule using proposed substitution with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
  - k. Cost information, including a proposal of change, if any, in the Contract Sum.
  - l. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.
  - m. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
3. Architect's Action: If necessary, Architect will request additional information or documentation for evaluation within seven days of receipt of a request for substitution. Architect will notify Contractor of acceptance or rejection of proposed substitution within 15 days of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.
- a. Forms of Acceptance: Change Order, Construction Change Directive, or Architect's Supplemental Instructions for minor changes in the Work.

## 1.5 QUALITY ASSURANCE

- A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

## 1.6 PROCEDURES

- A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.



## **PART 2 - PRODUCTS**

### **2.1    SUBSTITUTIONS**

- A.     Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than 15 days prior to time required for preparation and review of related submittals.
1.     Conditions: Architect will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, Architect will return requests without action, except to record noncompliance with these requirements:
- a.     Requested substitution is consistent with the Contract Documents and will produce indicated results.
  - b.     Substitution request is fully documented and properly submitted.
  - c.     Requested substitution will not adversely affect Contractor's construction schedule.
  - d.     Requested substitution has received necessary approvals of authorities having jurisdiction.
  - e.     Requested substitution is compatible with other portions of the Work.
  - f.     Requested substitution has been coordinated with other portions of the Work.
  - g.     Requested substitution provides specified warranty.
  - h.     If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.
- B.     Substitutions for Convenience: Not allowed unless otherwise indicated.

## **PART 3 - EXECUTION (Not Used)**

**END OF SECTION 012500**

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## **SECTION 012900 - PAYMENT PROCEDURES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SUMMARY**

- A. This Section specifies administrative and procedural requirements necessary to prepare and process Applications for Payment.

#### **1.3 DEFINITIONS**

- A. Schedule of Values: A statement furnished by Contractor allocating portions of the Contract Sum to various portions of the Work and used as the basis for reviewing Contractor's Applications for Payment.

#### **1.4 SCHEDULE OF VALUES**

- A. Coordination: Coordinate preparation of the Schedule of Values with preparation of Contractor's Construction Schedule.
  - 1. Correlate line items in the Schedule of Values with other required administrative forms and schedules, including the following:
    - a. Application for Payment forms with Continuation Sheets.
    - b. Submittals Schedule.
    - c. Contractor's Construction Schedule.
  - 2. Submit the Schedule of Values to Architect at earliest possible date but no later than seven days before the date scheduled for submittal of initial Applications for Payment.
- B. Format and Content: Use the list of 'Work Items' in Section 011000-Summary of the Work as a guide to establish line items for the Schedule of Values. Provide at least one line item for each Work Item listed.
  - 1. Identification: Include the following Project identification on the Schedule of Values:
    - a. Project name and location.
    - b. Contractor's name and address.
    - c. Date of submittal.
  - 2. Submit draft of AIA Document G703 Continuation Sheets.
  - 3. Arrange the Schedule of Values in tabular form with separate columns to indicate the following for each item listed:

- a. Work Item reference number (WI-#).
  - b. Description of the Work.
  - c. Change Orders (numbers) that affect value.
  - d. Dollar value.
- 1) Percentage of the Contract Sum to nearest one-hundredth percent, adjusted to total 100 percent.
- 4. Provide a breakdown of the Contract Sum in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Coordinate with the Project Manual Section 011000-Summary of the Work. Provide additional line items under each 'Work Item' for principal subcontract amounts under that 'Work Item' where appropriate.
  - 5. Round amounts to nearest whole dollar; total shall equal the Contract Sum.
  - 6. Provide a separate line item in the Schedule of Values for each part of the Work where Applications for Payment may include materials or equipment purchased or fabricated and stored, but not yet installed.
    - a. Differentiate between items stored on-site and items stored off-site. If specified, include evidence of insurance or bonded warehousing.
  - 7. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion, and for total installed value of that part of the Work.
  - 8. Each item in the Schedule of Values and Applications for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
    - a. Temporary facilities and other major cost items that are not direct cost of actual work-in-place may be shown either as separate line items in the Schedule of Values or distributed as general overhead expense, at Contractor's option.
    - b. *Include a separate line-item for "Construction Closeout Documentation" with a value of 1.5% of the total contract amount. Reduce other line items accordingly. Payment for this line item will only be made after acceptable closeout documentation listed in this and other sections is received and approved.*
  - 9. Schedule Updating: Update and resubmit the Schedule of Values before the next Applications for Payment when Change Orders or Construction Change Directives result in a change in the Contract Sum.

## 1.5 APPLICATIONS FOR PAYMENT

- A. Each Application for Payment shall be consistent with previous applications and payments as certified by Architect and paid for by Owner.
  - 1. Initial Application for Payment, Application for Payment at time of Substantial Completion, and final Application for Payment involve additional requirements.

- B. **Payment Application Times:** Progress payments shall be submitted to Architect by the first day of the month. The period covered by each Application for Payment is one month, ending on the last day of the month.
- C. **Payment Application Forms:** Use AIA Document G702 and AIA Document G703 Continuation Sheets as form for Applications for Payment.
- D. **Application Preparation:** Complete every entry on form. Notarize and execute by a person authorized to sign legal documents on behalf of Contractor. Architect will return incomplete applications without action.
1. Entries shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
  2. Include amounts of Change Orders and Construction Change Directives issued before last day of construction period covered by application.
- E. **Transmittal:** Submit 3 signed and notarized original copies of each Application for Payment to Architect. One copy shall include waivers of lien and similar attachments if required.
1. Transmit each copy with a transmittal form listing attachments and recording appropriate information about application.
- F. **Waivers of Mechanic's Lien:** With each Application for Payment, submit waivers of mechanic's lien from every entity who is lawfully entitled to file a mechanic's lien arising out of the Contract and related to the Work covered by the payment.
1. Submit partial waivers on each item for amount requested in previous application, after deduction for retainage, on each item.
  2. When an application shows completion of an item, submit final or full waivers.
  3. Owner reserves the right to designate which entities involved in the Work must submit waivers.
  4. **Waiver Forms:** Submit waivers of lien on forms, executed in a manner acceptable to Owner.
- G. **Initial Application for Payment:** Administrative actions and submittals that must precede or coincide with submittal of first Application for Payment include the following:
1. Schedule of Values.
  2. Contractor's Construction Schedule.
  3. Submittals Schedule.
- H. **Application for Payment at Substantial Completion:** After issuing the Certificate of Substantial Completion, submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
1. Include documentation supporting claim that the Work is substantially complete and a statement showing an accounting of changes to the Contract Sum.
  2. This application shall reflect Certificates of Partial Substantial Completion issued previously for Owner occupancy of designated portions of the Work.

- I. Final Payment Application: Submit final Application for Payment with releases and supporting documentation not previously submitted and accepted, including, but not limited, to the following:
  1. AIA Document G706A, "Contractor's Affidavit of Release of Liens."
  2. AIA Document G707, "Consent of Surety to Final Payment."
  3. Evidence that claims have been settled.
  4. Final, liquidated damages settlement statement.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION 012900**

## **SECTION 013300 - SUBMITTAL PROCEDURES**

### **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. Submittal schedule requirements.
2. Administrative and procedural requirements for submittals.

- B. Related Requirements:

1. Section 012500 "Substitution Procedures" for submitting substitutions for material and product requirements specified.
2. Section 012900 "Payment Procedures" for submitting Applications for Payment and the schedule of values
3. Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
4. Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
5. Section 017810 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
6. Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Owner's personnel.

#### **1.3 DEFINITIONS**

- A. Action Submittals: Written and graphic information and physical samples that require Architect/Engineer's or Owner's Authorized Representative's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."
- B. Informational Submittals: Written and graphic information and physical samples that do not require Architect/Engineer's or Owner's Authorized Representative's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."
- C. Closeout Submittals: Written and graphic information and physical samples that do not require Architect/Engineer's or Owner's Authorized Representative's responsive action that are submitted at project closeout, refer to Section 017700 – Closeout Procedures. Submittals may be rejected for not complying with requirements. Closeout submittals are those submittals indicated in individual Specification Sections as "closeout submittals."

- D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.
- E. Wherever in the specifications or upon the drawings the words “directed,” “required,” “ordered,” “designated,” “prescribed,” or words of like import are used, it shall be understood that the “direction,” “requirement,” “order,” “designation,” or “prescription,” of the A/E is intended and similarly the words “approved,” “acceptable,” “satisfactory,” or words of like import shall mean “approved by,” or “acceptable to,” or “satisfactory to” the A/E, unless otherwise expressly stated.
- F. Where “as shown,” “as indicated,” “as detailed,” or words of similar import are used, it shall be understood that the reference is made to the drawings accompanying this contract unless stated otherwise. The word “provided” as used herein shall be understood to mean “provide complete in place,” that is “furnished and installed.”
- G. Substitutions: For Contractor-proposed substitution requests, refer to Section 012500 – Substitution Procedures.

#### 1.4 SUBMITTAL LOG

- A. Submittal Log: Contractor shall prepare a submittal log that includes a list of submittals, arranged by in chronological order Division and Section.
  - 1. Each Section in the Submittal Log shall include the submittals required in the specification manual(s). There are three types of submittals that may be included in each Section. The submittal types are action submittals (A), informational submittals (I), and closeout submittals (C). Refer to “Definitions” Article for descriptions of each submittal type.

#### 1.5 SUBMITTAL PROCEDURES

- A. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.
  - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
  - 2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
  - 3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
  - 4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections so processing will not be delayed because of need to review submittals concurrently for coordination.
    - a. Architect/Engineer or Owner’s Authorized Representative reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.



- B. Review submittals prior to transmittal; determine and verify field measurements, field construction criteria, manufacturer's catalog numbers, and conformance of submittal with requirements of contract documents.
- C. Contractor shall be responsible for quantities and dimensions shown on submittals taken from Contract Drawings.
- D. Make submittals promptly in such sequence as to cause no delay in Work. Only the Contractor shall submit submittals to Architect/Engineer's or Owner's Authorized Representative's. Contractor shall number transmittals consecutively and shall indicate the submittal procedure number being followed.
- E. All submittals shall include the Contractor's Material Submittal Cover form. Reference the attached sample copy for completion of the document. Complete all fields in the Contractor's Material Submittal Cover form that are highlighted with RED text in the sample copy. MSWord format of the document will be provided to the Contractor at the preconstruction meeting for use in developing submittals.
  - 1. Each submittal item shall be listed individually on the Material Submittal Cover.
  - 2. Provide one submittal for each Section. Do not combine Sections unless material for the Sections are dependent on each other.
  - 3. Include list of drawings with shop drawing submittals.
  - 4. Provide field dimensions, clearly identified as such, as applicable where requested by subcontractor or fabricator.
  - 5. Relation to adjacent or critical features of Work or materials, as applicable.
  - 6. Applicable standards, such as ASTM or Federal Specification numbers.
  - 7. Identification of deviations from Contract Drawings.
  - 8. Identification of revisions on the resubmitted.
  - 9. Additional information as required by Contract Documents.
  - 10. 8" x 3" blank space for Contractor's approval stamp and Architect/Engineer stamps.
  - 11. Contractor's approval stamp.
- F. Options: Identify options requiring selection by Architect.
- G. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Architect on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.
- H. Apply the Contractor's approval stamp, signed may be provided on a transmittal cover sheet for the entire submittal or on each sheets of shop drawings, on cover sheet of each product data item, and on stamp sheet of each sample certifying to review of submittal, verification of products, field measurements and field construction criteria, and coordination of information within submittal with requirements of Work and of Contract Documents. Use of electronic stamps and signatures are permitted.
  - 1. Contractor's stamp shall only note that the submittal has been approved. The use of words or phrases such as "reviewed" or "reviewed as noted" is not acceptable.

- I. Submittals without Contractor's approval stamp and submittals which, in Architect/Engineer's or Owner's Authorized Representative's opinion are incomplete, contain numerous errors, or have not been checked or have only been checked superficially, will be returned without comments. Any resulting delays shall be Contractor's responsibility.
- J. Action Submittal Requirements: All action submittals required for each Section must be provided in a single submission for review. Partial submittals are not permitted and will be returned without comment. Where partial submittals are necessary the Contractor shall coordinate with Architect/Engineer or Owner's Authorized Representative.
- K. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in the Submittal Log and the individual Specification Sections.
  - 1. Email: Prepare submittals as PDF package, and transmit to Architect/Engineer or Owner's Authorized Representative by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Architect.
    - a. Architect/Engineer or Owner's Authorized Representative will return annotated file. Annotate and retain one copy of file as a digital Project Record Document file.
- L. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.
  - 1. Note date and content of previous submittal.
  - 2. Note date and content of revision in label or title block and clearly indicate extent of revision.
  - 3. Resubmit submittals until they are marked with approval notation from Architect/Engineer or Owner's Authorized Representative action stamp.
- M. Fabrication of products or beginning work prior to the return of approved submittals is at the risk of the Contractor.
- N. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.
- O. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Architect's action stamp.

## 1.6 SUBMITTAL REQUIREMENTS

- A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.
  - 1. If information must be specially prepared for submittal because standard published data are unsuitable for use, submit as Shop Drawings, not as Product Data.
  - 2. Mark each copy of each submittal to show which products and options are applicable.

3. Include the following information, as applicable:
    - a. Manufacturer's catalog cuts.
    - b. Manufacturer's product specifications.
    - c. Standard color charts.
    - d. Statement of compliance with specified referenced standards.
    - e. Testing by recognized testing agency.
    - f. Application of testing agency labels and seals.
    - g. Notation of coordination requirements.
    - h. Availability and delivery time information.
  4. For equipment, include the following in addition to the above, as applicable:
    - a. Wiring diagrams that show factory-installed wiring.
    - b. Printed performance curves.
    - c. Operational range diagrams.
    - d. Clearances required to other construction, if not indicated on accompanying Shop Drawings.
  5. Submit Product Data before Shop Drawings, and before or concurrent with Samples.
- B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Architect's digital data drawing files is otherwise permitted.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
    - a. Identification of products.
    - b. Schedules.
    - c. Compliance with specified standards.
    - d. Notation of coordination requirements.
    - e. Notation of dimensions established by field measurement.
    - f. Relationship and attachment to adjoining construction clearly indicated.
    - g. Seal and signature of professional engineer if specified.
  2. Paper Sheet Size: Except for templates, patterns, and similar full-size Drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches (215 by 280 mm), but no larger than 30 by 42 inches (750 by 1067 mm).
- C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other materials.
1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
  2. Identification: Permanently attach label on unexposed side of Samples that includes the following:
    - a. Project name and submittal number.

- b. Generic description of Sample.
  - c. Product name and name of manufacturer.
  - d. Sample source.
  - e. Number and title of applicable Specification Section.
  - f. Specification paragraph number and generic name of each item.
3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics, and identification information for record.
4. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.
- a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
  - b. Samples not incorporated into the Work, or otherwise designated as Owner's property, are the property of Contractor.
5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
- a. Number of Samples: Submit full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Architect will return submittal with options selected.
6. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
- a. Number of Samples: Submit sets of Samples. Architect will retain one Sample set; remainder will be returned.
    - 1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
    - 2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three sets of paired units that show approximate limits of variations.
- D. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
  2. Manufacturer and product name, and model number if applicable.
  3. Number and name of room or space.
  4. Location within room or space.
- E. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of architects and owners, and other information specified.
- F. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.
- G. Certificates:
1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
  2. Installer Certificates: Submit written statements on manufacturer's letterhead certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
  3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
  4. Material Certificates: Submit written statements on manufacturer's letterhead certifying that material complies with requirements in the Contract Documents.
  5. Product Certificates: Submit written statements on manufacturer's letterhead certifying that product complies with requirements in the Contract Documents.
  6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specification and Procedure Qualification Record on AWS forms. Include names of firms and personnel certified.
- H. Test and Research Reports:
1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.
  2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.

3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in the Contract Documents.
5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:
  - a. Name of evaluation organization.
  - b. Date of evaluation.
  - c. Time period when report is in effect.
  - d. Product and manufacturers' names.
  - e. Description of product.
  - f. Test procedures and results.
  - g. Limitations of use.

#### 1.7 DELEGATED-DESIGN SERVICES

- A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.
  1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Architect.
- B. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF file of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.
  1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

#### 1.8 ARCHITECT'S REVIEW

- A. Action Submittals: Architect will review each submittal, indicate corrections or revisions required, and return it.
  1. PDF Submittals: Architect will indicate, via markup on each submittal, the appropriate action.

- B. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.
- C. Architect will return without review submittals received from sources other than Contractor.
- D. Submittals not required by the Contract Documents will be returned by Architect without action.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION 013300**

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## CONTRACTOR'S MATERIAL SUBMITTAL FORM

BTL FAA Hangar Rehabilitation Project

<b>TO: (Architect)</b> Mead & Hunt, Inc.	<b>FROM: (General Contractor)</b> -	DATE -
PREVIOUS SUBMISSION NUMBER <i>(If applicable)</i> -	SUBMISSION NUMBER -	SUBMITTAL <input type="checkbox"/> NEW <input type="checkbox"/> RESUBMITTAL
ARCHITECT'S PROJECT NUMBER 0228800-170289.01	CONTRACTOR'S PROJECT NUMBER -	

**THE CONTRACTOR SHALL PROVIDE SUBMITTALS REQUIRED FOR ONLY (1) ONE SPECIFICATION SECTION ONLY. SUBMITTALS FOR MULTIPLE SECTIONS WILL RE RETURNED WITHOUT REIEW.**

**THE CONTRACTOR TO PROVIDE ALL ACTION ITEMS FOR A SPECIFICATION SECTION IN A SINGLE SUBMITTAL FOR COMPLETE REVIEW BY THE A/E. PARTIAL SUBMITTAL OF ACTION ITEMS WILL BE RETURNED WITHOUT REVIEW UNLESS THE PARTIAL SUBMITTAL WAS PREVIOUSLY APPROVED BY THE A/E.**

### TO BE COMPLETED BY CONTRACTOR

SUBMITTAL ID	LINE No.	REFERENCE No.	SPECIFICATION SECTION TITLE	DESCRIPTION OF MATERIAL <i>(Product Data, Shop Drawings, Test Reports, Warranties, etc.)</i>
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-
-	-	-	-	-

**BY COMPLETING THIS FORM, THE UNDERSIGNED CONTRACTOR CERTIFIES THAT THE MATERIAL COMPLIES WITH ALL SPECIFICATIONS OF SUBJECT CONTRACT.**

DATE -	TYPE OR PRINT NAME AND TITLE -	SIGNATURE
-----------	-----------------------------------	-----------

### CONTRACTOR COMMENTS:

1. -

2. -

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## **SECTION 013523 – OPERATIONAL SAFETY ON AIRPORTS DURING CONSTRUCTION**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SUMMARY**

- A. Section includes:

1. Guidelines for operational safety on and at airports during construction.

#### **1.3 SUBMITTALS**

- A. Safety Plan Compliance Document (SPCD):

1. Submit a SPCD to the Airport Director of Engineering describing how it will comply with the requirements of the Construction Safety and Phasing Plan (CSPP) and supplying any details that could not be determined before contract award. The SPCD must include a certification statement by the contractor that indicates it understands the operational safety requirements of the CSPP and it asserts it will not deviate from the approved CSPP and SPCD unless written approval is granted by the airport operator. Any construction practice proposed by the contractor that does not conform to the CSPP and SPCD may impact the airport's operational safety and will require a revision to the CSPP and SPCD and re-coordination with the airport operator and the Federal Aviation Administration (FAA) in advance.
2. Have available at all times copies of the CSPP and SPCD for reference by the airport and its representatives, and by subcontractors and contractor employees.
3. Ensure that construction personnel are familiar with safety procedures and regulations on the airport. Provide a point of contact who will coordinate an immediate response to correct any construction-related activity that may adversely affect the operational safety of the airport. Many projects will require 24-hour coverage.
4. Identify in the SPCD the contractor's on-site employees responsible for monitoring compliance with the CSPP and SPCD during construction. At least one of these employees must be on-site whenever active construction is taking place.
5. Conduct inspections in sufficient frequency to ensure construction personnel comply with the CSPP and SPCD and that there are no altered construction activities that could create potential safety hazards.
6. Restrict movement of construction vehicles and personnel to permitted construction areas by flagging, barricading, erecting temporary fencing, or providing escorts, as appropriate and as specified in the CSPP and SPCD.
7. Ensure that no contractor employees, employees of subcontractors or suppliers, or other persons enter any part of the air operations area (AOA) from the construction site unless authorized.

8. Prior to being allowed any access to the Aircraft Operations Area or Aircraft Movement Area, the Contractor shall prepare, submit and receive approval of a Safety Plan Compliance Document.

#### 1.4 SAFETY PLAN COMPLIANCE DOCUMENT

- A. The SPCD should include a general statement by the construction contractor that he/she has read and will abide by the CSPP. In addition, the SPCD must include all supplemental information that could not be included in the CSPP prior to the contract award.
- B. The contractor statement should include the name of the contractor, the title of the project CSPP, the approval date of the CSPP, and a reference to any supplemental information (that is, "I, Name of Contractor, have read the Title of Project CSPP, approved on Date, and will abide by it as written and with the following additions as noted:"). The supplemental information in the SPCD should be written to match the format of the CSPP indicating each subject by corresponding CSPP subject number and title. If no supplemental information is necessary for any specific subject, the statement, "No supplemental information," should be written after the corresponding subject title. The SPCD should not duplicate information in the CSPP.
  1. Coordination: Discuss details of proposed safety meetings with the airport operator and with contractor employees and subcontractors.
  2. Phasing: Discuss proposed construction schedule elements, including:
    - a. Duration of each phase.
    - b. Daily start and finish of construction, including "night only" construction if applicable.
  3. Areas and operations affected by the construction activity: These areas and operations should be identified in the CSPP and should not require an entry in the SPCD.
  4. Contractor access: Provide the following:
    - a. Details on how the contractor will maintain the integrity of the airport security fence (gate guards, daily log of construction personnel, and other).
    - b. Listing of individuals requiring driver training (for certificated airports and as requested).
    - c. Radio communications.
    - d. Types of radios and backup capabilities.
      - 1) Who will be monitoring radios.
      - 2) Whom to contact if the air traffic control tower (ATCT) cannot reach the contractor's designated person by radio.
    - e. Details on how the contractor will escort material delivery vehicles.
  5. Foreign Object Debris (FOD) Management: Discuss equipment and methods for control of FOD, including construction debris and dust.

6. Hazardous Material (HAZMAT) Management: Discuss methods for responding to discovery of hazardous materials.
7. Notification of Construction Activities: Provide the following:
  - a. Contractor points of contact: Primary and Secondary.
  - b. Contractor emergency contact: 24-hour.
8. Inspection Requirements: Discuss daily (or more frequent) inspections and special inspection procedures.
9. Underground Utilities: Discuss proposed methods of identifying and protecting underground utilities.
10. Penalties: Penalties should be identified in the CSPP and should not require an entry in the SPCD.
11. Marking and Signs for Access Routes: Discuss proposed methods of demarcating access routes for vehicle drivers.
12. Other limitations on construction should be identified in the CSPP and should not require an entry in the SPCD.
13. Record Keeping & Close-out: Contractor shall maintain a log of all inspections, meeting minutes, drawings and other relevant data. Records shall be well organized and maintained in notebook style on site. Records shall be accessible to the owner for review at all times. A copy of the SPCD and associated documents shall be submitted along with project close-out documentation.

## 1.5 CONTRACTOR ACCESS

### A. Vehicle and Pedestrian Operations.

1. Contractor's Employee Parking.
  - a. No parking of contractor personal vehicles (POV) within the Secure Area/ Air Operations Area (airside).
  - b. See Construction Safety Phasing Plan drawing G-050.
2. Contractor construction vehicle parking.
  - a. Contractor construction vehicles required to be on airfield side of the terminal shall be limited to five vehicles for the prime contractor and all subcontractors. See drawing sheet G-050 for contractor vehicle parking area.

### B. Construction Site Entrance Locations.

1. Contractor construction vehicle access shall be via the gates shown on drawing sheet G-050.
  - a. All security personnel that will be controlling airfield access are required to attend a security workshop conducted by the airport operator.

### C. Lighting of Contractor Construction Vehicles

1. Contractor vehicles, not escorted, shall be equipped with a flashing light that is mounted on the uppermost part of the vehicle.
2. Lights shall be flashing yellow and visible from any direction, day and night, including from the air. Lights must have a peak intensity within the range of 40-400 candelas (effective) from 0 degrees horizontal up to 10 degrees above horizontal and for 360 degrees horizontal. The upper limit of 400 candelas (effective) is necessary to avoid damage to night vision.
3. From 10 degrees to 15 degrees above the horizontal plane, the light output must be 1/10th of peak intensity or between 4 and 40 candelas (effective).
4. Lights must flash at 75 +/- 15 flashes per minute.

D. Vehicle Speed

1. Motor vehicles shall not operate at a speed that endangers property or persons in the area.
2. Motor vehicles shall not exceed 10 mph on the aircraft parking ramps or 25 mph on the perimeter/service roads. All vehicles are restricted to 5 mph when in close proximity to aircraft.

E. Involvement in Vehicle Accidents.

1. Any persons damaging any airfield light fixture or other airport facility shall report such damage to the Airport Manager's office immediately and shall be responsible for his or her share of any costs required to repair or replace damaged fixtures or facility.

F. Description of proper vehicle operations

1. Proper vehicle operations shall be adhered to at all times and consistent with instruction provided by owner during an on-site Driver's Training briefing. See "Training Requirements for Vehicle Drivers" Article below.
2. Vehicles operating within the secure area must display a temporary ramp placard. Vehicles within the secure area may only be operated by persons having successfully completed Non-Movement Area Driver Training or be escorted by a person having successfully completed Non-Movement Area Driver Training. To obtain a Temporary Ramp Placard, the applicant must provide proof of insurance, vehicle registration and operator drivers' license.

G. Training Requirements for Vehicle Drivers

1. Contractor's personnel and all subcontractors' personnel that have successfully completed badging and that will be operating a vehicle or equipment within the secure area shall complete an approximately 30 minute Non-Movement Area Driver Training class and pass a written exam. Applicants must possess a valid driver's license and a Badge in order to participate in Non-Movement Area Driver Training.

H. Required escorts.

1. All drivers requiring access to the secure area, that do not have driver training, shall be escorted by a person that have successfully completed Non-Movement Area Driver Training, that are currently badged and permitted accordingly.
2. All drivers requiring access to Movement Areas that do not have Movement Area training shall be escorted by a person that has successfully completed Movement Area Driver Training and are currently badged and permitted accordingly.

I. Situational awareness.

1. Contractor's personnel shall constantly monitor their surroundings. Contractor must confirm by personal observation that no aircraft is approaching their position even when the airfield is closed.
2. Vehicle drivers must confirm by personal observation that no aircraft is approaching their position during operation in the Non-Movement Area. In addition, it is the responsibility of the escort vehicle driver to verify the movement/position of all escorted vehicles at any given time.

J. Two-way radio communication procedures.

1. General: The contractor shall provide and maintain battery powered portable two way radios equipped with top mounted antennas and capable of tuning air navigation band frequencies. Radios must be kept in good working order at all times work is in progress on the airfield. The contractor shall have an operator that speaks fluent English, available for radio contact at all times.
2. Areas requiring two-way radio communication with the air traffic control tower (ATCT).
  - a. Vehicular traffic crossing active movement areas must be controlled either by two-way radio with the ATCT, escort, flagman, signal light, or other approved means.
3. Frequencies to be used: The contractor shall monitor the ground control frequency (verify with airport) at all times personnel are on the airfield.
4. Proper radio usage, including read back requirements: Contractor shall be trained by the airport operator for proper radio usage prior beginning any work.
5. Proper phraseology, including the International Phonetic Alphabet.
  - a. Not applicable.
6. Light gun signals.
  - a. Not applicable

**1.6 FOREIGN OBJECT DEBRIS (FOD) MANAGEMENT**

- A. Waste and loose materials, commonly referred to as FOD, are capable of causing damage to aircraft landing gears, propellers, and jet engines. Construction contractors must not leave or place FOD on or near aircraft movement areas. Materials capable of creating FOD must be continuously removed during the construction project.

1. Vehicle Cleanliness & Security: All contractors shall keep vehicle contents and payload secure at all times to prevent migration of materials onto airfield pavements.
2. Pavement Sweeping/Vacuuming: Contractor shall maintain by sweeping and vacuuming or other approved means, all pavements impacted by contractor operations, including, but not limited to haul route pavements and pavement adjacent to the area of work. Pavements shall be kept free of construction materials, dirt, rocks and other debris at all times for the life of the project by vacuuming operations during all working hours. Contractor shall vacuum all pavements utilized/impacted by contractor operations at the end of each work shift. At the completion of the construction and prior to final acceptance, the contractor shall conduct a final vacuuming of all pavements utilized/impacted by contractor operations. Steel wire broom vehicles are not permitted.
3. FOD Fence: Not applicable.
4. Inspections: Not applicable.
5. Inspection of FOD procedures and effectiveness shall be part of all inspections.

#### 1.7 CONSTRUCTION SAFETY AND PHASING PLAN

- A. The initial Construction Safety and Phasing Plan developed for this project is provided as on drawing G-050. This document is to be used as a start for a contractor's CSPP.

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION 013523**



## **SECTION 013553 – SECURITY PROCDEDURES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including other Division 1 Specification Sections, apply to this Section.

#### **1.2 SUMMARY**

- A. Section includes:
1. FAA security requirements
  2. Guidelines for the Contractor to obtain badges.

#### **1.3 FAA SECURITY REQUIREMENTS**

- A. All personnel working within the fenced FAA site and hangar building must comply with FAA security requirements for this facility, per "Section 9 Security Clauses" following this section.
- B. General security requirements include:
1. Everyone on site must have a favorable background check and be badged or be escorted by someone who has had a full background check, is badged and has escort authority. Note that no airport staff is currently badged.
  2. Everyone inside the secured site and building must sign in and out each day, and wear/display either their FAA badge or a temporary badge for the day indicating they are under escort, per FAA protocols.
  3. Since this is a leased facility, there will be no FAA Resident Engineers serving to coordinate and submit lists of personnel to the FAA VAP system for badging as is otherwise typical for FAA-owned projects. In this case, an off-site FAA Security POC ("Trusted Agent") would be assigned to be kept aware of and approve badges, but a local 'Contractor Representative' (badged) will be responsible for submitting the proposed lists of personnel to the FAA VAP. The Contractor shall identify and provide a badged person who will be involved throughout the project to be responsible for this role.
  4. The Badging process begins with the 'Contractor Representative' submitting a list of personnel to be badged to the FAA VAP. The FAA then emails each of them with instructions/paperwork they must each send in to the FAA (expeditiously to avoid delays). After receipt of the applicant's paperwork, the FAA completes the background checking process with interim results within about 5-7 days if there are no derogating results which can slow the process considerably.
  5. Badging fees are covered by the FAA at approximately \$194 each, therefore unnecessary badging shall be avoided.
  6. There is no specific limit to how many individuals each badged person can escort. It is preferable to limit the ratio to 5:1 if possible, but up to 10:1 is

acceptable if all are within sight of the badged escort for both interior and exterior work.

7. The Contractor shall be responsible to provide his own badged escorts as needed to complete the work, and shall not rely on badged staff from the FAA, the Airport or the A/E.
  8. Due to the varied nature of the work items in this facility, it is anticipated that the GC will have a few badged escorts, and will require at least one foreman for each trade/subcontractor to be badged so they can escort their own crew.
  9. It is acceptable to 'hand-off' escort authority to another badged escort during the day.
  10. The local FAA staff will lock-down sensitive information and equipment to the extent they feel is necessary during the work.
  11. The badging process and requirements are further explained in FAA's 'Section 9 Security Clauses' following this section.
  12. Due to the processing time involved, Contractor is advised to begin this process immediately upon notice of award.
- C. These procedures and charges are subject to change, possibly without advance notice.

#### 1.4 BADGE RETURN

- A. All badges issued under this project must be returned to FAA Operations prior to final payment being made to the contractor.
- B. Lost badges will be assessed an administrative fee of \$75.00.

#### **PART 2 - PRODUCTS (Not Used)**

#### **PART 3 - EXECUTION (Not Used)**

**END OF SECTION 013553**

**ATTACHMENT TO SECTION 013553**

**SECURITY REQUIREMENTS**

**FIS Facility**

**W K Kellogg Airport**

**UNITED STATES OF AMERICA  
DEPARTMENT OF TRANSPORTATION  
FEDERAL AVIATION ADMINISTRATION**

**SECTION 9 - SECURITY CLAUSES**

**6.9.1 Facility Security (JUL 2017)**

Security requirements for Government occupied space must meet minimum-security accreditation standards for the type of facility covered by this Lease. The FAA Facility Security Management Program defines facility security accreditation standard levels. The security requirements identified below are tailored specifically for the type of facility covered by this Lease. The Lessor shall provide or make accommodation to provide for all the security requirements listed herein for the leased premises covered by this Lease agreement:

[INSERT INSTRUCTIONS: List security requirements received from the Servicing Security Element (SSE) here. If you did not receive a list of security requirements from the SSE, then insert 'None' here]

The local Servicing Security Element (SSE) will determine any additional security upgrades that are required to meet accreditation and shall conduct a final security assessment of the building. The Lessor shall provide maintenance services to the security upgrades installed by the Lessor within the leased premises and covered under this Lease.

**6.9.2 Foreign Nationals as Contractor Employees (OCT 2014)**

A. Definition. "Foreign National" is any citizen or national of a country other than the United States who has not immigrated to the United States and is not a Legal Permanent Resident (LPR) of the United States.

B. Each contractor or subcontractor employee under this contract, having access to FAA facilities, sensitive information, or resources must be a citizen of the United States, or an alien who has been lawfully admitted for permanent residence as evidenced by Alien Registration Receipt Card Form I-151, or who presents other evidence from the U.S. Citizenship and Immigration Service that employment must not affect his/her immigration status.

C. Aliens and foreign nationals proposed under this contract must meet the following conditions in accordance with FAA Order 1600.72A, chapter 5, paragraph 7 & 8:

1. Must have resided within the United States for three (3) of the last five (5) years unless a waiver of this requirement is requested and approved in accordance with the requirements stated in FAA Order 1600.72A, chapter 5, paragraph 9;

2. A risk or sensitivity level designation can be made for the position; and
3. The appropriate security-related background investigation/inquiry can be adequately conducted.

D. Foreign nationals proposed under this contract must meet the following additional conditions:

1. Provide a current passport and place of birth in order to successfully pass a Security background check in accordance with the FAA Order 1600.74, Visitor Policy, and
2. Successfully pass an export control review as outlined in FAA Order 1240.13 FAA Export Control Compliance.

E. Interim suitability requirements may not be applied unless the position is low/moderate in risk, and/or temporary, and/or is not in a critical area position.

### **6.9.3 Lessor Personnel Suitability Requirements (JAN 2017)**

A. This clause applies to the extent that this Lease requires Lessor's employees, agents, subcontractors, or consultants to have unescorted access to FAA:

1. Facilities;
  2. Sensitive information; and/or;
  3. Resources regardless of the location where such access occurs, and none of the exceptions of FAA Order 1600.72A, Lessor and Industrial Security Program, Chapter 5, paragraphs 4, 6, 7 and 8 pertain.
- Definitions of applicable terminology are contained in the corresponding guidance and FAA Order 1600.72A, Appendix A.

B. Consistent with FAA Order 1600.72A, the SSE has approved designated risk levels for the positions under the lease. Those designated risk levels are:

(INSTRUCTION: Insert designated risk areas based on 1600-77(s) approved by the SSE and REMOVE THIS INSTRUCTION, prior to issuing lease)

C. If a National Agency Check with Inquiries (NACI) or other investigation is required for a given position, the Lessor will submit to the RECO a point of contact (POC) that will enter applicant data into the Vendor Applicant Process (VAP) system (vap.faa.gov). VAP is a FAA system used to process and manage security information for FAA contractor personnel. Each contract may have up to five (5) POCs. Once designated, a VAP administrator will provide each POC a Web ID and password.

The type of investigation conducted will be determined by the position risk level designation for all duties, functions, and/or tasks performed and will serve as the basis for granting a favorable employment suitability authorization as described in FAA Order 1600.72A. If an employee has had a previous U.S. Government conducted background investigation, which meets the requirements of Chapter 5 of FAA Order 1600.72A and Homeland Security Presidential Directive 12 (HSPD-12), it will be accepted by the FAA. However, the FAA reserves the right to conduct further investigations, if necessary. The contract may include positions that are temporary, seasonal, or under escort only. In such cases, an OPM Position Designation or FAA Form 1600-77 for each specific position will be established, as the investigative requirements may differ from the NACI.

The following information must be entered into VAP by the POC for each applicant requiring an investigation:

1. Name;
2. Date and place of birth (city and state);
3. Social Security Number (SSN);
4. Position and office location;

5. Lease or Contract number;
6. Current e-mail address and telephone number (personal or work); and
7. Any known information regarding current security clearance or previous investigations (e.g. the name of the investigating entity, type of background investigation conducted, contract number, labor category (position), and approximate date the previous background investigation was completed).

If a prior investigation exists and there has not been a two (2) year break in service by the applicant, the SSE will notify the Lessor that no investigation is required and that final suitability is approved.

If no previous investigation exists, the SSE will send the applicant an e-mail (this step may be delegated to the VAP POC):

1. Stating that no previous investigation exists and the applicant must complete a form through the Electronic Questionnaires for Investigations Processing (eQIP) system
2. Instructing the applicant how to enter and complete the eQIP form;
3. Providing where to send/fax signature and release pages and other applicable forms; and
4. Providing instructions regarding fingerprinting.

The applicant must complete the eQIP form and submit other required material, within fifteen (15) days of receiving the e-mail from the SSE.

For items to be submitted outside eQIP, the Lessor must submit the required information, with a transmittal letter referencing the lease number to:

Headquarters Contracts:  
Manager, Personnel Security Division, AIN-400  
800 Independence Avenue, S.W., Room 315  
Washington, D.C. 20591

Regional and Center Contracts:

(INSTRUCTION: Insert appropriate Regional or Center information here or enter "none" if not applicable and REMOVE THIS INSTRUCTION, prior to issuing lease)

D. The Lessor must submit the information required by paragraph C of this clause, for any new employee not listed in the Lessor's initial submission, who will have unescorted access to the leased premises.

E. The RECO will provide notice to the Lessor when any Lessor's employee is found to be unsuitable or otherwise objectionable, or whose conduct appears contrary to the public interest, or inconsistent with the best interest of national security. The Lessor must take appropriate action, including the removal of such employee from working within the leased premises, at their own expense. Once action has been taken, the Lessor will report the action to the RECO and SSE.

F. No Lessor's employee will work in a high, moderate, or low risk position unless the SSE has received all forms necessary to conduct any required investigation and has authorized the Lessor's employee to begin work.

G. The Lessor must notify the RECO within one (1) business day after any employee identified pursuant to paragraph C of this clause, is terminated from performance within the leased premises. This notification must be done utilizing the Removal Entry screen of VAP. If FAA issued the terminated employee an identification card, the Lessor must collect the card and submit it to the SSE.

H. The Lessor must request a report from the VAP on at least a semiannual basis in order to reconcile discrepancies and then must notify the SSE of these discrepancies as soon as possible.

I. The RECO may also, after coordination with the SSE and other security specialists, require Lessor's employees to submit any other security information (including additional fingerprinting) deemed reasonably necessary, to protect the interests of the FAA. In this event, the Lessor must provide, or cause each of its employees to provide, such security information to the SSE, to meet the requirements of paragraph C of this clause.

J. The Lessor and/or subcontractor(s) must contact the SSE within one (1) business day in the event an employee is arrested (detained by law enforcement for any offenses, other than minor traffic offenses) or is involved in theft of Government property, or the Lessor becomes aware of any information that may raise a question about the suitability of a Lessor's employee.

K. Failure to submit information required by this clause, within the time required, may be determined by the RECO as a material breach of the lease.

L. If subsequent to the effective date of this lease, the security classification or security requirements under this contract are changed by the Government and if the changes cause an increase or decrease in direct contract costs or otherwise affect any other term or condition of this lease, the lease will be subject to an equitable adjustment.

M. The Lessor agrees to insert terms that conform substantially to the language of this clause, including paragraph K. but excluding any reference to the "Changes" clause of this lease, in all subcontracts under this lease that involve access and where the exceptions under Chapter 5, FAA Order 1600.72A do not apply.

N. Lessor's employees who have not undergone a background investigation must be escorted at all times. In some instances, a Lessor's employee may be required to serve as an escort. To serve as an escort, a Lessor's employee must have a favorably adjudicated fingerprint check and initiated a NACI with FAA.

#### **6.9.4 Access to FAA Systems and Government-Issued Keys, Personal Identity Verification (PIV) Cards, and Vehicle Decals (JAN 2017)**

A. It may become necessary for the Government to grant access to FAA systems or issue keys, PIV cards, vehicle decals, and/or access control cards to Lessor's employees. Prior to or upon completion or termination of the work required hereunder, the Lessor must return all such Government-issued items and submit a request to terminate all user accounts on applicable FAA systems to the issuing office with notification to the RECO. When Lessor's employees who have been issued such items are terminated or no longer required to perform the work, the Government-issued items must be returned to the Government and a request submitted for the termination of FAA system access within three (3) business days after termination of the employee. Improper use, possession or alteration of FAA issued keys, PIV Cards and/or vehicle decals is subject to penalties under Title 18, USC 499, 506, 701, and 1030.

B. In the event such keys, PIV Cards, or vehicle decals are lost, stolen, or not returned, the Lessor understands and agrees that the Government may, in addition to any other withholding provision of the contract, withhold [Insert Appropriate Amount] for each key, PIV Card, and vehicle decal lost, stolen, or not returned. If the keys, PIV Cards, or vehicle decals are not returned within thirty (30) calendar days from the date the withholding action was initiated, any amount so withheld must be forfeited by the Lessor.

C. Access to aircraft ramp/hangar areas is authorized only to those persons displaying a flight line identification card and for vehicles, a current ramp permit issued pursuant to Title 49, Part 1542, Code of Federal Regulations.

D. The Government retains the right to inspect inventory, or audit PIV Cards, keys, vehicle decals, and access control cards issued to the Lessor in connection with the lease at the convenience of the Government. Any items not accounted for, to the satisfaction of the Government will be assumed to be lost and the provisions of section B apply.

E. Keys must be obtained from the facility manager who will require the Lessor to sign a receipt for each key obtained. Lost or stolen keys, PIV Cards, vehicle decals, and access control cards must immediately be reported concurrently to the RECO, facility manager and the SSE. Electronic keying cards are handled in the same manner as metal keys.

F. Each employee, during all times of on-site performance at the [Insert Location] must prominently display his/her current and valid PIV card on the front portion of his/her body between the neck and waist. Each PIV card holder must not affix pins, stickers, or other decorations to the PIV.

1. Prior to any Lessor's employee obtaining a PIV Card or vehicle decals, the Lessor is required to enter data for each employee into the VAP. From the information entered into the VAP, the SSE will determine whether final suitability can be granted due to the existence of a previous investigation, or will initiate the Lessor's applicant into the eQIP system so that the applicant can complete the investigative forms. Interim suitability cannot be granted until the eQIP form is completed, and fingerprints and signature pages are submitted to the SSE. When an interim is granted by the SSE, the individual may begin work under escort until their OPM fingerprint check has been returned and successfully adjudicated. Once the OPM fingerprint check has been successfully adjudicated, they can then be badged. If the employee requires a PIV card, a fingerprint check must be completed and favorably adjudicated by the SSE prior to approval or issuance of the PIV card.

2. To obtain the PIV card, Lessor's employee must submit an identification Card/Credential Application (DOT 1681) signed by the employee and by the authorized trusted agent (when applicable) and also by the authorized sponsor to the RECO. The DOT 1681 must contain, as a minimum, under the "Credential Justification" heading, the name of the Lessor/company, the lease number or the appropriate acquisition identification number, the expiration date of the lease or the task (whichever is sooner), and the required signatures. The Lessor will be notified when the DOT 1681 has been approved and is ready for processing. Arrangements for processing the identification cards, including photographs and lamination can be made by contacting the RECO or the facility manager.

3. The Lessor must contact the SSE to obtain the procedures that the Lessor's employees must utilize to obtain their PIV Card.

G. The Lessor is responsible for ensuring final out-processing is accomplished for all departing employees. Final out-processing must be accomplished by close of business on the employee's final workday or the next day under special conditions. The SSE must be notified in writing and ensure that all FAA media, including the PIV card, are returned to the SSE.

END OF ATTACHMENT TO SECTION 013553

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## **SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SUMMARY**

- A. This Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

#### **1.3 PROJECT CONDITIONS**

- A. Temporary Use of Permanent Facilities: Engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Owner's acceptance, regardless of previously assigned responsibilities.

### **PART 2 - PRODUCTS**

#### **2.1 TEMPORARY FACILITIES**

- A. Storage Sheds: At contractor's option, provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations, located in location approved by Owner.
  - 1. Store combustible materials apart from building.
- B. Construction Trailer: At contractor's option provide temporary job trailer in location approved by Owner and make own arrangements for temporary power, heat and communications.

#### **2.2 EQUIPMENT**

- A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

### **PART 3 - EXECUTION**

#### **3.1 TEMPORARY UTILITY INSTALLATION**

- A. General: Connect to existing service in location approved by Owner.
- B. Water Service: Connect to Owner's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Owner. At Substantial Completion, restore these facilities to condition existing before initial use.

- C. Sanitary Facilities: Provide temporary toilets, wash facilities, and drinking water for use of construction personnel. Comply with requirements of authorities having jurisdiction for type, number, location, operation, and maintenance of fixtures and facilities.
- D. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.
  - 1. Prior to commencing work, isolate the HVAC system in area where work is to be performed.
    - a. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
    - b. Maintain negative air pressure within work area using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
  - 2. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
  - 3. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.
- E. Electric Power Service: Connect to Owner's existing electric power service. Maintain equipment in a condition acceptable to Owner.
- F. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.
  - 1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.

### 3.2 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Contractor shall observe and follow all security access and control in accordance with the Airport's and FAA's requirements. The instructions and requirements are included elsewhere within the specifications.
  - 1. The contractor shall obtain the required security access badges for unescorted personnel that will work in the secure areas of the airport property.
  - 2. The contractor shall meet the requirements for personnel that will work in the secure areas of the airport property that will be escorted by a designated badged supervisor.
- B. Contractor shall provide temporary barriers and screening as noted on the construction drawings or otherwise needed. Coordinate limits with the Owner's agent.
- C. Contractor shall limit dust and dirt migration.
  - 1. Protect air-handling equipment.
  - 2. Provide walk-off mats at each entrance.

3. Provide dust control generated by the work at the site.
4. Provide the migration of dirt washing from the site into adjacent areas due to storm water runoff.

### **3.3 OPERATION, TERMINATION, AND REMOVAL**

- A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.
- B. Maintenance: Maintain owner's facilities in good operating condition until removal.
- C. Termination and Removal: Remove each temporary barrier and screening when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
  1. Materials and facilities that constitute temporary facilities are property of Contractor. Owner reserves right to take possession of Project identification signs.
  2. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements specified in Division 1 Section "Closeout Procedures."

**END OF SECTION 015000**

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## **SECTION 016000 - PRODUCT REQUIREMENTS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and comparable products.

#### **1.2 DEFINITIONS**

- A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.
1. Named Products: Items identified by manufacturer's product name, including make or model number or other designation shown or listed in manufacturer's published product literature that is current as of date of the Contract Documents.
  2. New Products: Items that have not previously been incorporated into another project or facility. Products salvaged or recycled from other projects are not considered new products.
  3. Comparable Product: Product that is demonstrated and approved by Architect/Engineer through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.

#### **1.3 ACTION SUBMITTALS**

- A. Comparable Product Request Submittal: Submit request for consideration of each comparable product. Identify basis-of-design product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
1. Include data to indicate compliance with the requirements specified in "Comparable Products" Article.
  2. Architect's/Engineer's Action: If necessary, Architect/Engineer will request additional information or documentation for evaluation within seven days of receipt of a comparable product request. Architect/Engineer will notify Contractor of approval or rejection of proposed comparable product request within 15 days

of receipt of request, or seven days of receipt of additional information or documentation, whichever is later.

- a. Form of Architect's/Engineer's Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
- b. Use product specified if Architect/Engineer does not issue a decision on use of a comparable product request within time allocated.

B. Basis-of-Design Product Specification Submittal: Comply with requirements in Section 013300 "Submittal Procedures." Show compliance with requirements.

#### 1.4 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

#### 1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and to determine that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.

## 1.6 PRODUCT WARRANTIES

- A. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
1. Manufacturer's Warranty: Written warranty furnished by individual manufacturer for a particular product and specifically endorsed by manufacturer to Owner.
  2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Owner.
- B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.
1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
  2. Specified Form: When specified forms are included with the Specifications, prepare a written document using indicated form properly executed.
  3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

## **PART 2 - PRODUCTS**

### 2.1 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
  2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
  3. Owner reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
  4. Where products are accompanied by the term "as selected," Architect/Engineer will make selection.
  5. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
- B. Product Selection Procedures:
1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
    - a. Sole product may be indicated by the phrase: "Subject to compliance with requirements, provide the following: ..."

2. Sole Manufacturer/Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.
    - a. Sole manufacturer/source may be indicated by the phrase: "Subject to compliance with requirements, provide products by the following: ..."
  3. Non-Limited List of Products: Where Specifications include a list of names of both available manufacturers and products, provide one of the products listed, or an unnamed product, which complies with requirements.
  4. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will be considered unless otherwise indicated.
  5. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed, or a product by an unnamed manufacturer, which complies with requirements.
  6. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, and include a list of manufacturers, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product by one of the other named manufacturers.
- C. Visual Matching Specification: Where Specifications require "match Architect's/Engineer's sample," provide a product that complies with requirements and matches Architect's sample. Architect's decision will be final on whether a proposed product matches.
- D. Visual Selection Specification: Where Specifications include the phrase "as selected by Architect from manufacturer's full range" or similar phrase, select a product that complies with requirements. Architect will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

## 2.2 COMPARABLE PRODUCTS

- A. Conditions for Consideration of Comparable Products: Architect/Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Architect may return requests without action, except to record noncompliance with these requirements:
1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant product qualities include attributes such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
  2. Evidence that proposed product provides specified warranty.



3. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
4. Samples, if requested.

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION 016000**

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## **SECTION 017000 - EXECUTION REQUIREMENTS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SUMMARY**

- A. This Section includes general procedural requirements governing execution of the Work including, but not limited to, the following:
1. General installation of products.
  2. Progress cleaning.
  3. Protection of installed construction.
  4. Correction of the Work.
- B. Related Sections include the following:
1. Section 017329-"Cutting and Patching" for procedural requirements for cutting and patching necessary for the installation or performance of other components of the Work.

### **PART 2 - PRODUCTS (Not Used)**

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Existing Conditions: The existence and location of site improvements, utilities, and other construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.
1. Before construction, verify the location and points of connection of utility services.
- B. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
  2. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  3. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.

4. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. **Field Measurements:** Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- B. **Space Requirements:** Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- C. **Review of Contract Documents and Field Conditions:** Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Architect. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

### 3.3 INSTALLATION

- A. **General:** Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  1. Make vertical work plumb and make horizontal work level.
  2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. **Tools and Equipment:** Do not use tools or equipment that produce harmful noise levels.
- F. **Templates:** Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- G. **Anchors and Fasteners:** Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Architect.
  2. Allow for building movement, including thermal expansion and contraction.
  3. Coordinate installation of anchorages. 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.
- H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.
- I. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

### **3.4 PROGRESS CLEANING**

- A. General: Clean Project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
  2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 deg F (27 deg C).
  3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
- B. Site: Maintain Project site free of waste materials and debris.
- C. Work Areas: Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
1. Remove liquid spills promptly.
  2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.
- F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- G. Waste Disposal: Burying or burning waste materials on-site will not be permitted. Washing waste materials down sewers or into waterways will not be permitted.

- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

### 3.5 PROTECTION OF INSTALLED CONSTRUCTION

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.

### 3.6 CORRECTION OF THE WORK

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Section 017329 - "Cutting and Patching."
  - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

**END OF SECTION 017000**

## **SECTION 017329 – CUTTING AND PATCHING**

### **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. Procedural requirements for cutting and patching.

#### **1.3 DEFINITIONS**

- A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.
- B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

#### **1.4 QUALITY ASSURANCE**

- A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.
- B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that result in increased maintenance or decreased operational life or safety.
- C. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity that result in reducing their capacity to perform as intended, or that result in increased maintenance or decreased operational life or safety.
- D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in the Architect's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- A. General: Comply with requirements specified in other Sections.

- B. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.
  - 1. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.
  - 1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
  - 2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Temporary Support: Provide temporary support of Work to be cut.
- B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
- C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
- D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.

### **3.3 PERFORMANCE**

- A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.
  - 1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
- B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.
  - 1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.



2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
  3. Concrete/Masonry/Asphalt: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
  4. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
  5. Proceed with patching after construction operations requiring cutting are complete.
- C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.
1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
  2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
    - a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    - b. Restore damaged pipe covering to its original condition.
  3. Exterior Pavements: Where concrete and asphalt pavements are removed protect remaining pavement from damage. Make openings by sawing completely through existing pavement.
    - a. Pavement may be broken out after initial saw cuts in the event pavement thickness prevents cutting through.
    - b. Where sawing is not possible, make openings by drilling holes around perimeter of opening and the chipping out the pavement.
      - 1) Holes shall be sufficient in number to prevent damage to remaining pavement.
    - c. Oversize required openings in existing pavement by 1-inch on all sides and build back to required opening sized by means of the following:
      - 1) Concrete: Nonshrink grout epoxy bonded to the existing concrete.
      - 2) Asphalt: Cold-patch asphalt to existing.
  4. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.
    - a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over

entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

5. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
  6. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.
- D. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

**END OF SECTION 017329**

## **SECTION 017419 – CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SUMMARY**

- A. Section includes:
  - 1. Disposing of nonhazardous waste.

#### **1.3 DEFINITIONS**

- A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.
- B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.
- C. Disposal: Removal off-site of demolition and construction waste and deposit in landfill or incinerator acceptable to authorities having jurisdiction.

### **PART 2 - PRODUCTS (Not Used)**

### **PART 3 - EXECUTION**

#### **3.1 COLLECTION OF WASTE**

- A. Contractor to provide waste-collection containers in sizes adequate to hand waste from construction operations. Location of waste-collection containers to be coordinated with owner.
  - 1. Contractor to always maintain cover over the waste-collection containers with a rollback tarp. Windborne construction debris may become a hazard for aircraft and must be mitigated.
- B. Do not intermingle construction waste with the Owner's waste-collection containers.

#### **3.2 DISPOSAL OF WASTE**

- A. General: Remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

- B. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
- C. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
- D. Burning: Do not burn waste materials.
- E. Disposal: Remove waste materials from Owner's property and legally dispose of them.

**END OF SECTION 017419**

## **SECTION 017700 - CLOSEOUT PROCEDURES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SUMMARY**

- A. This Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
1. Inspection procedures.
  2. Warranties.
  3. Final cleaning.
- B. Related Sections include the following:
1. Division 1 Section "Payment Procedures" for requirements for Applications for Payment for Substantial and Final Completion, and for Closeout Documentation related line item required in Schedule of Values .
  2. Division 1 Section "Execution Requirements" for progress cleaning of Project site.
  3. Division 1 Section "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.
  4. Divisions 2 through 33 Sections for specific closeout and special cleaning requirements for the Work in those Sections.

#### **1.3 SUBSTANTIAL COMPLETION**

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
  2. Submit specific warranties, workmanship bonds, maintenance service agreements, final certifications, and similar documents.
  3. Prepare and submit Project Record Documents, operation and maintenance manuals, and similar final record information.
  4. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
  5. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
  6. Complete startup testing of systems.
  7. Submit test/adjust/balance records.
  8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.

9. Complete final cleaning requirements, including touchup painting.
10. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.

B. Inspection: Submit a written request for inspection for Substantial Completion. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.

1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
2. Results of completed inspection will form the basis of requirements for Final Completion.

#### 1.4 FINAL COMPLETION

A. Preliminary Procedures: Before requesting final inspection for determining date of Final Completion, complete the following:

1. Submit a final Application for Payment according to Division 1 Section "Payment Procedures."
2. Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

B. Inspection: Submit a written request for final inspection for acceptance. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

#### 1.5 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Preparation: Submit copy of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order.
2. Organize items applying to each space by major element, including categories for ceiling, individual walls, floors, equipment, and building systems.
3. Include the following information at the top of each page:
  - a. Project name.
  - b. Date.

- c. Name of Contractor.

## 1.6 WARRANTIES

- A. Submittal Time: Submit written warranties on request of Engineer for designated portions of the Work where commencement of warranties other than date of Substantial Completion is indicated.
- B. Partial Occupancy: Submit properly executed warranties within 15 days of completion of designated portions of the Work that are completed and occupied or used by Owner during construction period by separate agreement with Contractor.
- C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
  - 1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch (215-by-280-mm) paper.
  - 2. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.
- D. Provide additional copies of each warranty to include in operation and maintenance manuals.

## 1.7 SECURITY BADGES

- A. Upon completion of all work requiring access to the secure portions of the site, Contractor shall return all security badges issued to Contractor and his subcontractors for this project, in accordance with Section 013553 Security Procedures and the requirements of the issuing agency. Contractor shall pay all fines assessed for unreturned badges.

## **PART 2 - PRODUCTS**

### 2.1 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

## **PART 3 - EXECUTION**

### 3.1 FINAL CLEANING

- A. General: Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

- B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:
    - a. Remove tools, construction equipment, machinery, and surplus material from Project site.
    - b. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
    - c. Sweep concrete floors broom clean in unoccupied spaces.
    - d. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo if visible soil or stains remain.
    - e. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.
    - f. Remove labels that are not permanent.
    - g. Touch up and otherwise repair and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.
      - 1) Do not paint over "UL" and similar labels, including mechanical and electrical nameplates.
    - h. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
    - i. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
    - j. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
    - k. Clean ducts, blowers, and coils if units were operated without filters during construction.
    - l. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out bulbs, and those noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.
    - m. Leave Project clean and ready for occupancy.
- C. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.



## Project Close Out - Check List

Project: BTL FAA Hangar Rehabilitation Project      Project No.:0228800-170289

Description	Date Received	Initials	Distribution	Comments
Certificate of Occupancy				
Consent of Surety Company to Final Payment				
Contractor's Affidavit of Release of Liens & Claims				
Warranty of Construction				
As Built Drawings				
As Built Specifications				
O & M Manuals				
Certificate of Final Acceptance				
Security Badges				
Certified Final Pay Application				

**END OF SECTION 017700**

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## **SECTION 017810 - PROJECT RECORD DOCUMENTS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SUMMARY**

- A. This Section includes administrative and procedural requirements for Project Record Documents, including the following:
1. Record Drawings.
  2. Record Specifications.
  3. Record Product Data.
- B. Related Sections include the following:
1. Division 1 Section "Closeout Procedures" for general closeout procedures.
  2. Divisions 2 through 33 Sections for specific requirements for Project Record Documents of the Work in those Sections.

#### **1.3 SUBMITTALS**

- A. Record Drawings: Comply with the following:
1. Number of Copies: Submit one set of marked-up Record Drawings.
- B. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit one copy of each Product Data submittal.

### **PART 2 - PRODUCTS**

#### **2.1 RECORD DRAWINGS**

- A. Record Prints: Maintain one set of blue- or black-line white prints of the Contract Drawings and Shop Drawings.
1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Accurately record information in an understandable drawing technique.

- c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
2. Content: Types of items requiring marking include, but are not limited to, the following:
  - a. Dimensional changes to Drawings.
  - b. Revisions to details shown on Drawings.
  - c. Revisions to electrical circuitry.
  - d. Duct size and routing.
  - e. Changes made by Change Order or Change Directive.
  - f. Changes made following Engineer's written orders.
  - g. Details not on the original Contract Drawings.
  - h. Field records for variable and concealed conditions.
3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
4. Mark record sets with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

## 2.2 RECORD SPECIFICATIONS

- A. Preparation: Mark Specifications to indicate the actual product installation where installation varies from that indicated in Specifications, addenda, and contract modifications.

## 2.3 RECORD PRODUCT DATA

- A. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

## 2.4 MISCELLANEOUS RECORD SUBMITTALS

- A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

# **PART 3 - EXECUTION**

## 3.1 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.

**END OF SECTION 017810**

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## **SECTION 017823 - OPERATION AND MAINTENANCE DATA**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
1. Emergency manuals.
  2. Operation manuals for systems, subsystems, and equipment.
  3. Maintenance manuals for the care and maintenance of products, materials, systems and equipment.
- B. See Divisions 02 through 33 Sections for specific operation and maintenance manual requirements for the Work in those Sections.

#### **1.2 SUBMITTALS**

- A. Manual: Submit two copies of each manual in final form at least 15 days before final inspection. Architect will return copy with comments within 30 days after final inspection.
1. Correct or modify each manual to comply with Architect's comments. Submit 2 copies of each corrected manual within 15 days of receipt of Architect's comments.

### **PART 2 - PRODUCTS**

#### **2.1 MANUALS, GENERAL**

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain a title page, table of contents, and manual contents.
- B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:
1. Subject matter included in manual.
  2. Name and address of Project.
  3. Name and address of Owner.
  4. Date of submittal.
  5. Name, address, and telephone number of Contractor.
  6. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
1. Binders: Heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
    - a. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
  2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
  3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
  4. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
    - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

## 2.2 OPERATION MANUALS

- A. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and equipment descriptions, operating standards, operating procedures, operating logs, wiring and control diagrams, and license requirements.
- B. Descriptions: Include the following:
1. Product name and model number.
  2. Manufacturer's name.
  3. Equipment identification with serial number of each component.
  4. Equipment function.
  5. Operating characteristics.
  6. Limiting conditions.
  7. Performance curves.
  8. Engineering data and tests.
  9. Complete nomenclature and number of replacement parts.
- C. Operating Procedures: Include start-up, break-in, and control procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions; and required sequences for electric or electronic systems.



- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed, and identify color-coding where required for identification.

### 2.3 PRODUCT MAINTENANCE MANUAL

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Product Information: Include the following, as applicable:
  - 1. Product name and model number.
  - 2. Manufacturer's name.
  - 3. Color, pattern, and texture.
  - 4. Material and chemical composition.
  - 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and inspection procedures, types of cleaning agents, methods of cleaning, schedule for cleaning and maintenance, and repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- F. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

### 2.4 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including maintenance instructions, drawings and diagrams for maintenance, nomenclature of parts and components, and recommended spare parts for each component part or piece of equipment:

- D. Maintenance Procedures: Include test and inspection instructions, troubleshooting guide, disassembly instructions, and adjusting instructions that detail essential maintenance procedures:
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

### **PART 3 - EXECUTION**

#### **3.1 MANUAL PREPARATION**

- A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- B. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
- C. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
- D. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
  - 1. Do not use original Project Record Documents as part of operation and maintenance manuals.
- E. Comply with Division 01 Section "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

**END OF SECTION 017823**

## **SECTION 017900 - DEMONSTRATION AND TRAINING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. This Section includes administrative and procedural requirements for instructing Owner's personnel, including the following:
  - 1. Demonstration of operation of systems, subsystems, and equipment.
  - 2. Training in operation and maintenance of systems, subsystems, and equipment.
- B. See Divisions 02 through 33 Sections for specific requirements for demonstration and training for products in those Sections.

#### **1.2 QUALITY ASSURANCE**

- A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Preinstruction Conference: Conduct conference at Project Site. Review methods and procedures related to demonstration and training.
- C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals.

### **PART 2 - PRODUCTS**

#### **2.1 INSTRUCTION PROGRAM**

- A. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections.
- B. Training Modules: For each module, include instruction for the following:
  - 1. Basis of System Design, Operational Requirements, and Criteria: Include system and equipment descriptions, operating standards, regulatory requirements, equipment function, operating characteristics, limiting conditions, and performance curves.
  - 2. Documentation: Review emergency, operations, and maintenance manuals; Project Record Documents; identification systems; warranties and bonds; and maintenance service agreements.
  - 3. Emergencies: Include instructions on stopping; shutdown instructions; operating instructions for conditions outside normal operating limits; instructions on meaning of warnings, trouble indications, and error messages; and required sequences for electric or electronic systems.

4. Operations: Include startup, break-in, control, and safety procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions; operating procedures for emergencies and equipment failure; and required sequences for electric or electronic systems.
5. Adjustments: Include alignments and checking, noise, vibration, economy, and efficiency adjustments.
6. Troubleshooting: Include diagnostic instructions and test and inspection procedures.
7. Maintenance: Include inspection procedures, types of cleaning agents, methods of cleaning, procedures for preventive and routine maintenance, and instruction on use of special tools.
8. Repairs: Include diagnosis, repair, and disassembly instructions; instructions for identifying parts; and review of spare parts needed for operation and maintenance.

### **PART 3 - EXECUTION**

#### **3.1 INSTRUCTION**

- A. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
  1. Owner will furnish an instructor to describe Owner's operational philosophy.
- B. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.
  1. Schedule training with Owner with at least seven (7) days' advance notice.

**END OF SECTION 017900**

## **SECTION 033000 - 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. This section includes cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, as required for but not limited to the following:
  - 1. Miscellaneous footings
  - 2. Foundations for exterior light fixtures
  - 3. Interior slabs-on-grade (e.g. storage shed floor)
  - 4. Miscellaneous equipment pads
  - 5. Concrete infill for floor repairs
  - 6. Bollard foundations and fill
  - 7. Other miscellaneous concrete items not covered elsewhere
- B. Concrete work covered elsewhere:
  - 1. FAA 150/5370-10G Item P-501 "Portland Cement Concrete (PCC) Pavement" shall be used for aircraft apron, exterior concrete pavements and dumpster pad.

#### **1.3 DEFINITIONS**

- A. Cementitious Materials: Portland cement alone or in combination with one or more of the following: blended hydraulic cement, fly ash and other pozzolans, ground granulated blast-furnace slag, and silica fume; subject to compliance with requirements.

#### **1.4 SUBMITTALS**

- A. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
- B. 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.
- C. Field quality-control reports.
  - 1. See Part 3 paragraph "Field Quality Control" for report requirements.
  - 2. Submit both in-progress reports showing test results within 48 hours of each test and final reports including results of all tests completed for each sample.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on site 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 C 94/C 94M 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 C 1077 and ASTM E 329 for testing indicated.
- D. 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.
- E. Welding Qualifications: Qualify procedures and personnel according to AWS D1.4/D 1.4M, "Structural Welding Code - Reinforcing Steel."
- F. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
  - 1. ACI 301, "Specifications for Structural Concrete," Sections 1 through 5.
  - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- G. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Steel Reinforcement: Deliver, store, and handle steel reinforcement to prevent bending and damage. Avoid damaging coatings on steel reinforcement.

## **PART 2 - PRODUCTS**

### 2.1 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, plain, fabricated from as-drawn steel wire into flat sheets.

### 2.2 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), plain-steel bars, cut true to length with ends square and free of burrs.

- B. 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.

### 2.3 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
1. Portland Cement: ASTM C 150, Type I, gray. Supplement with the following:
    - a. Fly Ash: ASTM C 618, Class F or C.
    - b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- B. Normal-Weight Aggregates: ASTM C 33, Provide aggregates from a single source.
1. Coarse Aggregate: Coarse Aggregate shall conform to the requirement of ASTM C33, Class 4S or better and shall be graded as follows:
    - a. C.A. Mix 200: Use Size No. 357 or a combination of Size No. 3 and Size No. 57 with aggregate Size No. 3 comprising 35 to 65 percent of the total amount of coarse aggregate (2-inch nominal maximum aggregate size).
    - b. C.A. Mix 150: Use Size No. 467 or a combination of Size No.4 and Size No.67 with aggregate Size No.4 comprising 35 to 65 percent of the total amount of coarse aggregate (1-1/2-inch nominal maximum aggregate size).
    - c. C.A. Mix 100: Use Size No. 57 (1-inch nominal maximum aggregate size).
    - d. C.A. Mix 075: Use Size No. 67 (3/4-inch nominal maximum aggregate size).
    - e. C.A. Mix 050: Use Size No. 7 (1/2-inch nominal maximum aggregate size).
  2. Application of Coarse Aggregate: Nominal maximum size of coarse aggregate shall not exceed three-fourths of the minimum clear spacing between reinforcing bars, one-fifth of the narrowest dimension between sides of forms, or one-third of the thickness of slabs or toppings.
  3. Fine Aggregate: Fine aggregate shall conform to the requirements of ASTM C33, Paragraph 6, Grading, and shall be free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 94/C 94M and potable.

## 2.4 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- 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/C 494M, Type A.
  - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
  - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
  - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
  - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
  - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

## 2.5 VAPOR BARRIERS

- A. Sheet Vapor Barrier: ASTM E 1745, Class A, 15 mil thickness. Include manufacturer's recommended adhesive or pressure-sensitive tape.
  - 1. Maximum allowable water vapor transmission rate (WVTR) of less than 0.01 perms (grains/hour\*ft<sup>2</sup>\*in. HG) when tested per ASTM F 1249 or ASME E 96.
  - 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. Insulation Solutions, Inc.; Viper VaporCheck 16.
    - b. Raven Industries Inc.; Vapor Block 15.
    - c. Stego Industries, LLC; Stego Wrap 15 mil Class A.
- B. Fine-Graded Granular Material: Clean mixture of crushed stone, crushed gravel, and manufactured or natural sand; ASTM D 448, Size 10, with 100 percent passing a 3/8-inch (9.5-mm) sieve, 10 to 30 percent passing a No. 100 (0.15-mm) sieve, and at least 5 percent passing No. 200 (0.075-mm) sieve; complying with deleterious substance limits of ASTM C 33 for fine aggregates.

## 2.6 WET CURE, CURING MATERIALS

- A. Evaporation Retarder: Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
  - 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. BASF Construction Chemicals - Building Systems; Confilm.
    - b. ChemMasters; SprayFilm.
    - c. Dayton Superior Corporation; Sure Film (J-74).
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. (305 g/sq. m) when dry.



- C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.
- D. Water: Potable.

## 2.7 POST WET CURE, CURING MATERIALS

- A. Clear, Solvent-Borne, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A, 30% Solids by Weight.
  - 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. BASF Construction Chemicals - Building Systems; Kure-N-Seal 30 ES.
    - b. ChemMasters; Spray-Cure & Seal Plus.
    - c. Dayton Superior Corporation; Cure & Seal 1315 EF
    - d. Edoco by Dayton Superior Corporation; Cure & Seal 1315 EF.
    - e. Meadows, W. R., Inc.; CS-309/30.
    - f. Metalcrete Industries; Seal N Kure 30.

## 2.8 POST WET-CURE, PENETRATING SEALER MATERIALS

- A. Clear, Breathable, High-Performance, Solvent-Borne, Silane Sealer, 100% Silane by Weight
  - 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. BASF Construction Chemicals - Building Systems; Hydrozo 100
    - b. ChemMasters; Aquanil Plus 100
    - c. Dayton Superior Corporation; Weather Worker S-100 (J-29-A)

## 2.9 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber.
- B. Semirigid Joint Filler: Two-component, semirigid, 100 percent solids, aromatic polyurea with a Type A shore durometer hardness range of 90 to 95 per ASTM D 2240.
- C. Bonding Agent: ASTM C 1059/C 1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

## 2.10 REPAIR MATERIALS

- A. Repair Underlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch (3.2 mm) and that can be feathered at edges to match adjacent floor elevations.
  - 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.

2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
  3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by underlayment manufacturer.
  4. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C 109/C 109M.
- B. Repair Overlayment: Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/4 inch (6.4 mm) and that can be filled in over a scarified surface to match adjacent floor elevations.
1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
  2. Primer: Product of topping manufacturer recommended for substrate, conditions, and application.
  3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch (3.2 to 6 mm) or coarse sand as recommended by topping manufacturer.
  4. Compressive Strength: Not less than 5000 psi (34.5 MPa) at 28 days when tested according to ASTM C 109/C 109M.

## 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: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
1. Fly Ash: 25% maximum.
- C. 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.
- D. 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.

## 2.12 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Footings: Proportion normal-weight concrete mixture as follows:
1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
  2. Maximum Water-Cementitious Materials Ratio: 0.45.

3. Slump Limit: 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture.
4. Air content 5 percent, plus or minus 1.5 percent at point of delivery for 2-inch (51-mm) nominal maximum aggregate size.
5. Air Content: 5.5 percent, plus or minus 1.5 percent at point of delivery for 1-1/2-inch (38-mm) nominal maximum aggregate size.
6. Air Content: 6 percent, plus or minus 1.5 percent at point of delivery for 1-inch (25-mm) to 3/4-inch (19-mm) nominal maximum aggregate size.
7. Air Content: 7 percent, plus or minus 1.5 percent at point of delivery for 1/2-inch (13-mm) nominal maximum aggregate size.

**B. Slabs-on-Grade: Proportion normal-weight concrete mixture as follows:**

1. Minimum Compressive Strength: 3500 psi (27.6 MPa) at 28 days.
2. Maximum Cementitious Materials Content: 500 lb/cu. yd.
3. 1-1/2 inch nominal aggregate size
4. Maximum Water-Cementitious Materials Ratio: 0.50.
5. Slump Limit: 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture.
6. Air Content:
  - a. Interior: Do not allow air content of trowel-finished floors to exceed 3 percent.
  - b. Exterior: 6 percent, plus or minus 1.5 percent at point of delivery.
7. Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of 7.5 lb/cu. yd.
  - a. Products
    - 1) Forta Ferro
    - 2) FRC HPS 950

**C. Sidewalks, Curb and Gutter: Proportion normal-weight concrete mixture as follows:**

1. Minimum Compressive Strength: 4000 psi (27.6 MPa) at 28 days.
2. Minimum Cementitious Materials Content:
  - a. 1-1/2-inch nominal aggregate size: 470 lb/cu. yd. (279 kg/cu. m).
  - b. 1-inch nominal aggregate size: 520 lb/cu. yd. (309 kg/cu. m).
  - c. 3/4-inch nominal aggregate size: 540 lb/cu. yd. (320 kg/cu. m).
  - d. 1/2-inch nominal aggregate size: 610 lb/cu. yd. (348 kg/cu. m).
3. Slump Limit: 4 inches for concrete with verified slump
4. Air Content:
  - a. Exterior: 6 percent, plus or minus 1.5 percent at point of delivery.

**D. Concrete Toppings: Normal-weight concrete.**

1. Minimum Compressive Strength: 3500 psi at 28 days.
2. Maximum Cementitious Materials Content: 610 lb/cu. yd.
3. 1/2-inch nominal aggregate size
4. Slump Limit: 8 inches (200 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture.
5. Air Content: Do not allow air content of trowel-finished toppings to exceed 3 percent.
6. Synthetic Macro-Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than a rate of 6.0 lb/cu. yd.

a. Products

- 1) Forta Ferro
- 2) HGS 950

### 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 C 94/C 94M, and furnish batch ticket information.
1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

## **PART 3 - EXECUTION**

### 3.1 PROVISIONS FOR FINISHES

- A. Floor elevations shown on the floor plans are nominal finished floor elevations, and represent the top elevation of any finishes or flooring systems to be applied over the base slab.
- B. Depress slabs on grade where floor mats, ceramic tile, or other flooring systems or finishes are scheduled, specified or noted, to maintain full required base slab thickness and achieve finish floor elevations shown or noted.
- C. Depress slabs full thickness of special flooring systems where those systems are scheduled.
- D. Slope grades under sloped floors or grade to maintain full specified slab thickness at all times.
- E. Do not apply curing compounds to surfaces to receive subsequent coatings or bonded finishes. Wet cure only.

### 3.2 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.
  - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."
  - 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 VAPOR BARRIERS

- A. Sheet Vapor Barriers: Place, protect, and repair sheet vapor barrier according to ASTM E 1643 and manufacturer's written instructions.
  - 1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended tape.
- B. Granular Course: Where indicated, cover vapor barrier with fine-graded granular material, moisten, and compact with mechanical equipment to elevation tolerances of plus 0 inch (0 mm) or minus 3/4 inch (19 mm).

### 3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
  - 1. Do not cut or puncture vapor barrier. Repair damage and reseal vapor barrier before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would 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 D 3963/D 3963M. Use epoxy-coated steel wire ties to fasten epoxy-coated steel reinforcement.

### 3.5 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete. Place wall, floor, and curb isolation, contraction and construction joints as shown on plans or, where not covered on the plans, as specified herein.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by COR.
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. Locate joints for beams, elevated 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.
  3. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
  4. Space vertical joints in walls at 60'-0" maximum spacing. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
- C. Contraction Joints in Exposed Foundation Walls: Form by cant strips on both sides of wall, and space at 15' maximum and coincident with masonry control joints where possible
- D. 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. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3.2-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before concrete develops random contraction cracks and in no case more than 24 hours after concrete placement.
  2. If not shown or noted, provide contraction joints at maximum 15' spacing each way, or less as necessary to maintain approximately square panels, with consideration given to intersecting reentrant corners, in final locations as approved by the COR.
  3. Contraction joints shall be parallel to or perpendicular to column lines unless shown otherwise. Reinforcing shall run through center of joints unless otherwise indicated.
  4. Tooled joints not allowed.
- E. 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 (13 mm) or more than 1 inch (25 mm) below finished concrete surface where joint sealants, specified in Division 07 Section "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.
- F. Curb Joints: Joints in concrete curbs shall be coincident with same type of joints in floor slab wherever possible.
- G. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or asphalt coat one-half of dowel length to prevent concrete bonding to one side of joint.
- H. Cleaning: Before next section is placed, reinforcing bars shall be cleaned from concrete splashed on from placing previous section. Vertical and horizontal concrete surfaces shall be thoroughly cleaned of all laitance and thoroughly wetted before adjacent concrete is placed.

### 3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by COR.
- C. Deposit concrete 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. 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 to not 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 (150 mm) 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.
- D. 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.
- E. 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 (4.4 deg C) 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.
- F. Hot-Weather Placement: Comply with ACI 301 and as follows:
1. Maintain concrete temperature below 90 deg F (32 deg C) 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.

### 3.7 FINISHING FLOORS AND SLABS

- A. General: Comply with ACI 302.1R recommendations for screeding, restraighening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.
- B. 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 restraighening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces to receive trowel finish and to be covered with fluid-applied or sheet waterproofing, built-up or membrane roofing, or sand-bed terrazzo.
- C. 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 exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin-film-finish coating system.
- D. 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.
- E. Finish surfaces to the following tolerances, according to ASTM E 1155 (ASTM E 1155M), for a randomly trafficked floor surface:
1. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade. Levelness does not apply to slabs shown as slope to drain.

### 3.8 MISCELLANEOUS CONCRETE ITEMS

- 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: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

### 3.9 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 301 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 (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.
- 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 the remainder of the 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 slabs according to ACI 308.1, by the following methods:
1. Wet Cure: Moisture Curing or Moisture-Retaining-Cover Curing for a period of not less than seven (7) days.

- a. Moisture Curing: Keep surfaces continuously moist for not less than seven (7) days with the following materials:
    - 1) Water.
    - 2) Continuous water-fog spray.
    - 3) Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
  - b. 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 (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven (7) days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
2. Post-Wet Cure, Curing Compound:
- a. All new exposed interior and exterior flatwork and other new exposed concrete surfaces not scheduled, specified, or noted to receive post-cure penetrating sealers, ceramic tile, or other bonded systems, coatings, or finish materials shall receive a liquid- applied, post-wet cure, curing compound after wet curing seven (7) days as specified, to extend the curing process.
  - b. Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions immediately after the seven (7) day wet cure. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.

### 3.10 POST-WET CURE, PENETRATING SEALER:

- A. New concrete floors scheduled to be sealed on Room Finish Schedule shall receive a post-wet cure penetrating sealer after full seven (7) day wet cure and an additional 21-day drying/aging period.
- B. Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subject to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat.

### 3.11 JOINT FILLING

- A. Prepare, clean, and install joint filler according to manufacturer's written instructions.
- B. Remove dirt, debris, saw cuttings, curing compounds, and sealers from joints; leave contact faces of joint clean and dry.
- C. Install semirigid joint filler full depth in saw-cut joints and at least 2 inches (50 mm) deep in formed joints. Overfill joint and trim joint filler flush with top of joint after hardening.

### 3.12 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by COR. Remove and replace concrete that cannot be repaired and patched to COR's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 (1.18-mm) sieve, using only enough water for handling and placing.
- C. 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 (0.25 mm) 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 (6 mm) 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 (25 mm) 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 (19-mm) 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 (25 mm) 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.
- D. Perform structural repairs of concrete, subject to COR's approval, using epoxy adhesive and patching mortar.
- E. Repair materials and installation not specified above may be used, subject to COR's approval.

### 3.13 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a qualified testing and inspecting agency to perform tests and inspections and to submit reports. This in no way relieves the Contractor of his responsibility to inspect and test his work for conformance to project requirements.
- B. 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.
  7. Verification of concrete strength before removal of shores and forms from beams and slabs.
- C. 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 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mixture placed each day.
  2. Slump: ASTM C 143/C 143M; 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.
  3. 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.
  4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when 80 deg F (27 deg C) and above, and one test for each composite sample.
  5. Compression Test Specimens: ASTM C 31/C 31M.
    - a. Cast and laboratory cure three sets of two standard cylinder specimens for each composite sample.
  6. Compressive-Strength Tests: ASTM C 39/C 39M; test one set of two specimens at 7 days, one set of two specimens at 28 days. In the event of a failed strength test one set of two specimens at 56 days.
    - a. 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.
  7. 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 (3.4 MPa).
  8. Test results shall be reported in writing to COR, 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.

9. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by COR but will not be used as sole basis for approval or rejection of concrete.
  10. 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 COR. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by COR.
  11. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
  12. Correct deficiencies in the Work that test reports and inspections indicate do not comply with the Contract Documents.
- D. Measure floor and slab flatness and levelness according to ASTM E 1155 (ASTM E 1155M) within 24 hours of finishing.

**END OF SECTION 033000**

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## **SECTION 055000 - 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 DESCRIPTION**

- A. Provide all labor, materials, and equipment to complete metal fabrications work as indicated in the Contract Documents.
- B. The Contractor shall take his own measurements, coordinate with equipment suppliers, and be solely responsible for proper fitting of the work under this Section to existing conditions.

#### **1.3 SUMMARY**

- A. Section Includes the following work as required for the project:
  - 1. Railings and guardrails
  - 2. Custom door thresholds
  - 3. Exterior wall mounted intake hoods
  - 4. Fabricated covers and guards
  - 5. Bollards
  - 6. Miscellaneous steel framing and supports for mechanical and electrical equipment
  - 7. Other miscellaneous steel fabrications.

#### **1.4 SUBMITTALS**

- A. Product Data: Manufacturer's descriptive literature, including details of construction, materials, dimensions, preparation anchoring, profiles, configurations and finishes for the following:
  - 1. Grout.
  - 2. Other miscellaneous metals and metal components.
- B. Shop Drawings: Show fabrication and installation details for metal fabrications.
  - 1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.

#### **1.5 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, "Structural Welding Code - Stainless Steel."
- C. Workmanship and finish shall be first class and equal to best practice in modern fabrication shops. Shearing, clipping and burning shall be neatly and accurately done and all portions of work exposed to view shall be neatly finished.

#### 1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication to meet the intent of the drawings and details.

#### 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 any anchorages and steel weld plates and angles to be cast into concrete. 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.

### **PART 2 - PRODUCTS**

#### 2.1 METALS, GENERAL

- 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.

#### 2.2 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Steel Tubing: ASTM A 500, cold-formed steel tubing.
- C. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40) unless otherwise indicated.
- D. Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

#### 2.3 NONFERROUS METALS

- A. Bronze Castings: ASTM B 584, Alloy UNS No. C83600 (leaded red brass) or No. C84400 (leaded semired brass).



- B. Nickel Silver Extrusions: ASTM B 151/B 151M, Alloy UNS No. C74500.
- C. Nickel Silver Castings: ASTM B 584, Alloy UNS No. C97600 (20 percent leaded nickel bronze).
- D. Stainless Steel: Type 304L or 316L as indicated or required for the given application. No. 4 finish where exposed.

#### 2.4 TUBULAR STEEL MEMBERS:

- A. Provide seal welded end plates/closure plates at ends of all tubular steel or cover plated beams exterior locations to prevent entry of water, dust and dirt.
- B. Provide prewelded backnuts inside members as necessary for bolted connections.

#### 2.5 FASTENERS

- A. General: Unless otherwise indicated, provide hot dip galvanized steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with hex nuts, ASTM A 563 (ASTM A 563M); and, where indicated, flat washers.
- C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless-steel bolts, ASTM F 593 (ASTM F 738M); with hex nuts, ASTM F 594 (ASTM F 836M); and, where indicated, flat washers.
- D. Anchor Bolts: ASTM F 1554, Grade 55, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.
  - 1. Hot-dip galvanized except at stainless steel components or unless otherwise noted.
  - 2. Stainless steel for stainless steel components and as noted.
- E. Eyebolts: ASTM A 489.
- F. Machine Screws: ASME B18.6.3 (ASME B18.6.7M).
- G. Lag Screws: ASME B18.2.1 (ASME B18.2.3.8M).
- H. Plain Washers: Round, ASME B18.22.1 (ASME B18.22M).
- I. Anchor Rods: ASTM F 1554, Grade 55.
  - 1. Configuration: Straight, headed or tacked nut.
  - 2. Nuts: ASTM A 563 (ASTM A 563M) heavy-hex carbon steel.
  - 3. Plate Washers: ASTM A 36/A 36M carbon steel.
  - 4. Washers: ASTM F 436 (ASTM F 436M), Type 1, hardened carbon steel.
  - 5. Finish: Hot dip galvanized.

J. Post-Installed Anchors:

1. Wedge Anchors: Threaded stud with integral cone expander and single piece expander clip. The stud shall be carbon steel with a minimum 70ksi tensile strength.
2. Epoxy Anchor: Anchoring adhesive shall be a two-component high solids, epoxy-based system. Anchor rod shall be A36 threaded rod. The anchor system shall be tested and qualified for performance in cracked and uncracked concrete.
3. Material for dry interior locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.
4. Material for exterior locations, wet interior locations, or as specifically noted: Stainless steel at stainless steel fabrications or if noted. Hot Dipped Galvanized steel elsewhere.

**2.6 MISCELLANEOUS MATERIALS**

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- C. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 3000 psi (20 MPa).

**2.7 FABRICATION, GENERAL**

- A. 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.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- C. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed work with accurate angles and surfaces and straight edges.
- E. 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.

- F. 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.
- G. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- H. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- I. 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.
  - 1. 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 (3.2 by 38 mm), with a minimum 6-inch (150-mm) embedment and 2-inch (50-mm) hook, not less than 8 inches (200 mm) from ends and corners of units and 24 inches (600 mm) o.c., unless otherwise indicated.

## 2.8 MISCELLANEOUS STEEL FABRICATIONS

- 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 steel.

## 2.9 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 miscellaneous steel per ASTM A123.

## 2.10 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.

## 2.11 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

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

## 2.12 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
  - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
  - 2. Galvanize after final cutting, welding and grinding.
- B. 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.
- C. Preparation for Shop Priming: Prepare surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- D. 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.

## 2.13 FIELD-APPLIED PAINT FINISH

- A. Field paint all exposed steel in accordance with the architectural finish schedule and "Painting" in Division 9 of the specifications.

## **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. Field welding to components embedded in concrete or masonry shall implement low-heat welding rods of smallest practical size and shall use multiple passes of smaller welds to achieve required weld size to minimize thermal expansion and distortion of embedded components.
  5. Paint effected areas with galvanizing repair coating.
- D. Headed anchor studs shall be installed using stud welding devices designed for that purpose.
- E. 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.
- F. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

### 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 equipment and piping securely to and rigidly brace from building structure.
- C. Support steel members on solid grouted masonry, concrete, or steel pipe columns. Secure members 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.

### 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 grout.
1. Use nonshrink grout, nonmetallic grout.
  2. 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 (0.05-mm) dry film thickness.
- B. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 099123 "Painting."
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.
- D. Stainless Steel Surfaces: Clean field welds and abraded areas and field buff or bead-blast to blend for uniform finish.

**END OF SECTION 055000**

## **SECTION 055213 - PIPE AND TUBE 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. Removable and fixed steel pipe and tube railings and guards.

#### **1.3 SUBMITTALS**

- A. Product Data: For the following:
  - 1. Railing brackets.
  - 2. Grout, anchoring cement, and paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

#### **1.4 QUALITY ASSURANCE**

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

#### **1.5 PROJECT CONDITIONS**

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

#### **1.6 COORDINATION AND SCHEDULING**

- 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 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 such items to Project site in time for installation.

- C. Schedule installation so wall attachments are made only to completed surfaces. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

## **PART 2 - PRODUCTS**

### **2.1 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: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

### **2.2 STEEL AND IRON**

- A. Tubing: ASTM A 500 (cold formed).
- B. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
  - 1. Provide galvanized finish for exterior installations and where indicated.
- C. Plates, Shapes, and Bars: ASTM A 36/A 36M.

### **2.3 FASTENERS**

- A. General: Provide the following:
  - 1. Ungalvanized-Steel Railings: Plated steel fasteners complying with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 for zinc coating.
- B. Fasteners for Anchoring Railings 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. Fasteners for Interconnecting Railing Components:
  - 1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
- 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 E 488, conducted by a qualified independent testing agency.



1. Material for Dry Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5, unless otherwise indicated.

## 2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Shop Primers and Paint Coatings: Provide primers and finish paint system to comply with Division 09 painting Sections.
- C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- D. 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.

## 2.5 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Assemble railings 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. Use connections that allow for removal and reinstallation of all railing assemblies (in segments).
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch (1 mm) unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- F. Connections: Fabricate railings with welded connections unless otherwise indicated.
- G. 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. 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 flux immediately.

4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- H. Form changes in direction as follows:
1. As detailed.
- I. Bend 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 of components.
- J. Close exposed ends of railing members with prefabricated end fittings.
- K. 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 (6 mm) or less.
- L. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work in a manner that allows railings to be removable unless otherwise indicated.
1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and prevent bracket or fitting rotation and crushing of substrate.
- M. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure. Provide for railing assemblies to be removable.
- N. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.

## 2.6 FINISHES, GENERAL

- 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: 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.

## 2.7 STEEL AND IRON FINISHES

- A. For nongalvanized steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors to be embedded in exterior concrete or masonry.

- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- C. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
- D. Shop-Painted Finish: Comply with Division 09 Section "Painting."
- E. Color: As selected by Architect from manufacturer's full range.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements have been clearly marked for Installer. Locate reinforcements and mark locations if not already done.

#### **3.2 INSTALLATION, GENERAL**

- A. Fit exposed connections together to form tight, hairline joints.
- B. 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.
  - 1. 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.
  - 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet (2 mm in 1 m).
  - 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet (5 mm in 3 m).
- C. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- D. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

#### **3.3 RAILING CONNECTIONS**

- A. 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.
- B. 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 (50 mm) beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches (150 mm) of post.

### 3.4 ANCHORING POSTS

- A. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
  - 1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.
  - 2. Provide post connections that allow for railing assemblies to be removable.

### 3.5 ATTACHING RAILINGS

- A. Provide connections at railing attachment to adjacent construction that allow for railing assemblies to be removable.
- B. Anchor railing ends at walls with round flanges anchored to wall construction and welded to railing ends.
- C. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.
- D. Attach railings to wall with wall brackets, except where end flanges are used. Provide brackets with 1-1/2-inch (38-mm) 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.

### 3.6 ADJUSTING AND CLEANING

- A. 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 (0.05-mm) 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.

### 3.7 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.

**END OF SECTION 055213**

## **SECTION 064023 - INTERIOR ARCHITECTURAL WOODWORK AND CABINETWORK**

### **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. Plastic-laminate cabinets and countertops.
  2. Plastic-laminate shelving.
  3. Cabinets and casework

#### **1.3 DEFINITIONS**

- A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

#### **1.4 SUBMITTALS**

- A. Product Data: For each type of product indicated, including panel products, high-pressure decorative laminate, solid-surfacing material, adhesives, cabinet hardware and accessories and finishing materials and processes.
- B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
1. Show details full size.
  2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
  3. Show locations and sizes of cutouts and holes for plumbing fixtures faucets soap dispensers and other items installed in architectural woodwork.
- C. Samples for Initial Selection:
1. Plastic laminates.
  2. Shop-applied transparent finishes.
  3. Thermoset decorative panels.
  4. Exposed cabinet hardware and accessories, one unit for each type and finish.
- D. Product Certificates: For each type of product, signed by product manufacturer.
- E. Woodwork Quality Standard Compliance Certificates: Written statement signed by fabricator certifying that all products provided comply with AWI Architectural Woodwork Quality Standards.

F. Qualification Data: For Installer and fabricator.

#### 1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that 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. Shop follows AWI Architectural Woodwork Quality Standards.
- B. Installer Qualifications: Fabricator of products complying with AWI Architectural Woodwork Quality Standards.
- 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. Preinstallation Conference: Conduct conference at Project site to coordinate work by other trades.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

#### 1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where woodwork is 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 woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
  - 2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

#### 1.8 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.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS**

- A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Wood Species and Cut for Transparent Finish: White Maple, plain sawn or sliced.
- C. Wood Products: Comply with the following:
  - 1. Hardboard: AHA A135.4.
  - 2. Softwood Plywood: DOC PS 1, Medium Density Overlay.
  - 3. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP-1, made with adhesive containing no urea formaldehyde.
- D. Thermoset Decorative Panels: Softwood plywood finished with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
- E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering high-pressure decorative laminates that may be incorporated into the Work include, but are not limited to, the following:
    - a. Formica Corporation.
    - b. Pionite Company.
    - c. Wilsonart International; Div. of Premark International, Inc.
    - d. Substitutions: Allowed in accordance with the requirements of Division 1 and General Conditions.
    - e. Product, Colors and Patterns: Basis of Design as indicated on Architectural Finishes Schedule.

### **2.2 CABINET HARDWARE AND ACCESSORIES**

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets, as indicated.
- B. Hinges: Blum "CLIP top BLUMOTION" concealed casework hinges, 180° opening or to suit conditions. Stanley and Soss concealed casework hinges of equal quality and operation are acceptable.
- C. Wire Pulls: Back mounted, solid metal, 4 inches (100 mm) long, 5/16 inch (8 mm) in diameter.
- D. Adjustable Shelf Standards and Supports: Knappe Vogt 255 type pilasters, recessed, with type 256 supports.
- E. Drawer Slides:

1. Blum "TANDEM plus BLUMOTION" 568 appropriate for drawer thickness, full extension, 110 to 125 lbs./pair rated. Stanley drawer slides of equal quality and operation are acceptable.
- F. Door Locks: Best Lock Company 5L Series, rim type, 5 barrel core, 5 pin cylinder. Finish: 626.
- G. Grommets for Cable Passage through Countertops: 2-inch (51-mm) OD, black, molded-plastic grommets and matching plastic caps with slot for wire passage.
- H. Miscellaneous:
1. Door and Drawer Bumpers: Blum SJ5312 or equal.
- I. Counter Supports: Rakks model EH-1824 for up to 30" deep counter, clear anodized aluminum. Provide two per counter where counters are not otherwise supported on base cabinets.
- J. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.
1. Satin Chromium Plated: BHMA 626 for brass or bronze base; BHMA 652 for steel base.
  2. Satin Stainless Steel: BHMA 630.
- K. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

### 2.3 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
- C. Adhesives, General: Do not use adhesives that contain urea formaldehyde.
- D. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
1. Wood Glues: 30 g/L.
  2. Contact Adhesive: 250 g/L.
- E. Adhesive for Bonding Plastic Laminate: Unpigmented contact cement.
1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.



## 2.4 FABRICATION, GENERAL

- A. Interior Woodwork Grade: Unless otherwise indicated, provide Custom-grade interior woodwork complying with referenced quality standard.
- B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
- C. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
  - 1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.
- D. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.

## 2.5 PLASTIC-LAMINATE CABINETS

- A. Grade: Custom.
- B. AWI Type of Cabinet Construction: Flush overlay.
- C. Construct to profiles and configurations shown on the drawings using plywood (particle board is not acceptable) with plastic laminate face and backer sheets.
- D. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
  - 1. Horizontal Surfaces Other Than Tops: Grade HGS.
  - 2. Postformed Surfaces: Grade HGP.
  - 3. Vertical Surfaces: Grade VGS.
  - 4. Edges: PVC edge banding, 0.12 inch (3 mm) thick, matching laminate in color, pattern, and finish.
- E. Materials for Semiexposed Surfaces:
  - 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, Grade VGS.
    - a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.12 inch (3 mm) thick, matching laminate in color, pattern, and finish.

- b. For semiexposed backs of panels with exposed plastic-laminate surfaces, provide surface of high-pressure decorative laminate, Grade VGS.
  - 2. Drawer Sides and Backs: Thermoset decorative panels.
  - 3. Drawer Bottoms: Thermoset decorative panels.
- F. Concealed Backs of Panels with Exposed Plastic Laminate Surfaces: High-pressure decorative laminate, Grade BKL.
- 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 indicated by laminate manufacturer's designations.
  - 2. As selected by Architect from laminate manufacturer's full range in the following categories:
    - a. Solid colors, matte finish.
    - b. Patterns, matte finish.
- H. Provide dust panels of 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

## 2.6 PLASTIC LAMINATE COUNTERTOPS

- A. Counter tops: Construct to profiles and configurations shown on the drawings.
  - 1. 4" Integral coved backsplash with radiused top edge.
  - 2. Field applied matching sidesplashes
  - 3. Full 180degree bullnosed front edge.
- B. Grade: Custom.
- C. Base Material/thickness: Particle board, 3/4 inch, double ply at edges.
- D. Colors, Patterns, and Finishes: Provide materials and products that result in colors of plastic laminate-surfacing material complying with the following requirements:
  - 1. As selected by Architect from manufacturer's full range.
  - 2. Comply with plastic laminate manufacturer's written recommendations for adhesives, sealers, fabrication, and finishing.
  - 3. Provide inconspicuous joints using reinforcement, backers, and color-matched fillers, sealants and adhesives recommended by the manufacturer.
  - 4. Install door hinges with appropriate expansion anchors.
- E. Drill holes in countertops for sinks, plumbing fittings and accessories in the field using templates from product manufacturers.

## 2.7 PLASTIC LAMINATE SHELVING

- A. Grade: Custom.

- B. Shelf Material: 3/4-inch (19-mm) thermoset decorative panel with PVC or polyester edge banding.
- C. Cleats: 3/4-inch (19-mm) thermoset decorative panel.

## **PART 3 - EXECUTION**

### **3.1 PREPARATION**

- A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing.

### **3.2 INSTALLATION**

- A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
- C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).
- D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.
- F. 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 (3 mm in 2400-mm) 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 (400 mm) o.c.
- G. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.

1. Align adjacent countertops and form flush clamped seams to comply with manufacturer's written recommendations. Carefully remove surface scratches, and clean entire surface.
  2. Install countertops with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
  3. Secure sidesplashes to walls with adhesive.
  4. Caulk space between backsplash and wall with sealant specified in Division 07 Section "Joint Sealants."
- H. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

### **3.3 ADJUSTING AND CLEANING**

- A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.
- B. Clean, lubricate, and adjust hardware.
- C. Clean woodwork on exposed and semiexposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

**END OF SECTION 064023**

## **SECTION 076200 - SHEET METAL FLASHING AND TRIM**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

**A. Section Includes:**

1. Custom-formed prefinished sheet metal fabrications.
2. Gutters and downspouts.

#### **1.2 PREINSTALLATION MEETINGS AND COORDINATION**

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

1. Review drawings and details to assure understanding of specific requirements and design intent.
2. Identify mock-ups required to affirm fit-up before production and installation.
3. Coordinate sequence of installation
4. Coordinate field inspections by Owner's Representative

**B. Drawings and details**

1. Contractor is advised to print flashing details at large scale for use in preinstallation coordination and during construction to ensure intent is understood and properly carried out.

#### **1.3 ACTION SUBMITTALS**

**A. Product Data: For each of the following**

1. Prefinished metal materials.
2. Accessory sealant and closure materials.

**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 expansion joints and expansion-joint covers, including showing direction of expansion and contraction from fixed points.
8. Include details of special conditions.
9. Include details of connections to adjoining work.

- C. Samples: For each exposed product and for each color and texture specified, 12 inches (300 mm) long by actual width.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Sample warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.
- B. Special warranty.

#### 1.6 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.

#### 1.7 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 E 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. 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 (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

## 2.2 SHEET METALS

- A. Use same base metal as existing flashings to remain to avoid corrosion from dissimilar metals. Use same base metal as existing gutters and downspouts to be replaced.
- B. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
- C. Aluminum Sheet: ASTM B209 (ASTM B209M), alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.
  1. Exposed Coil-Coated Finish:
    - a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  2. Color: As selected by Architect from manufacturer's full range.
  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 (0.013 mm).
- D. Stainless Steel Sheet: ASTM A240/A240M, Type 304, dead soft, fully annealed; with smooth, flat surface.
  1. Finish: ASTM A480/A480M, No. 4 (polished directional satin).
- E. Metallic-Coated Steel Sheet: Provide zinc-coated (galvanized) steel sheet in accordance with ASTM A653/A653M, G90 (Z275) coating designation; prepainted by coil-coating process to comply with ASTM A755/A755M.
  1. Surface: Smooth, flat and mill phosphatized for field painting and with manufacturer's standard clear acrylic coating on both sides.
  2. Exposed Coil-Coated Finish:
    - a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent polyvinylidene fluoride (PVDF) resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

3. Color: As selected by Architect from manufacturer's full range.
4. 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 (0.013 mm).

## 2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet Underlayment: Minimum 30 mils (0.76 mm) thick, consisting of a slip-resistant polyethylene- or polypropylene-film top surface laminated to a layer of butyl- or SBS-modified asphalt adhesive, with release-paper backing; specifically designed to withstand high metal temperatures beneath metal roofing. Provide primer in accordance with underlayment manufacturer's written instructions.
  1. Low-Temperature Flexibility: ASTM D1970/D1970M; passes after testing at minus 20 deg F (29 deg C) or lower.
- B. Slip Sheet: Rosin-sized building paper, 3 lb/100 sq. ft. (0.16 kg/sq. m) minimum.

## 2.4 MISCELLANEOUS MATERIALS

- A. Provide materials and types of fasteners, 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: 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.
  4. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel in accordance with ASTM A153/A153M or ASTM F2329.
- C. Solder:
  1. For Zinc-Coated (Galvanized) Steel: ASTM B32, Grade Sn50, 50 percent tin and 50 percent lead or Grade Sn60, 60 percent tin and 40 percent lead.



- 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 (13 mm) wide and 1/8 inch (3 mm) thick.
- E. Elastomeric Sealant: ASTM C920, elastomeric polyurethane 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. Reglets: Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated **with** interlocking counterflashing on exterior face, of same metal as reglet.
  - 1. Material: Stainless steel, 0.0188 inch (0.477 mm) thick, Aluminum, 0.024 inch (0.61 mm) thick, Galvanized steel, 0.022 inch (0.56 mm) thick, as required for given application.
  - 2. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
  - 3. Accessories:
    - a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
    - b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.
  - 4. Finish: With manufacturer's standard color coating.

## 2.5 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. Prepare and test mockups in field for proper fit and function prior to full shop fabrication.
  5. 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.
  6. 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 (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) 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 (25 mm) 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 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. Rivet joints where necessary for strength.
  3. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints where necessary for strength.

## 2.6 ROOF-DRAINAGE SHEET METAL FABRICATIONS

- A. Hanging Gutters:

1. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required.
  2. Fabricate in seamless sections between expansion joints indicated on drawings.
  3. Reuse existing gutter hangers. If additional support is needed furnish flat-stock gutter brackets and flat-stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard, but with thickness not less than twice the gutter thickness.
  4. Fabricate expansion joints, expansion-joint covers, and gutter accessories from same metal as gutters.
  5. Gutters with Girth up to 15 Inches (380 mm): Minimum material thickness:
    - a. Aluminum: 0.032 inch (0.81 mm) thick.
    - b. Galvanized Steel: 0.022 inch (0.56 mm) thick.
  6. Gutters with Girth 16 to 20 Inches (410 to 510 mm): Minimum material thickness:
    - a. Aluminum: 0.040 inch (1.02 mm) thick.
    - b. Galvanized Steel: 0.028 inch (0.71 mm) thick.
  7. Gutters with Girth 21 to 25 Inches (530 to 640 mm): Fabricate from the following materials:
    - a. Aluminum: 0.050 inch (1.27 mm) thick.
    - b. Galvanized Steel: 0.034 inch (0.86 mm) thick.
  8. Gutters with Girth 26 to 30 Inches (660 to 760 mm): Fabricate from the following materials:
    - a. Aluminum: 0.063 inch (1.60 mm) thick.
    - b. Galvanized Steel: 0.040 inch (1.02 mm) thick.
- B. Downspouts: Fabricate rectangular downspouts to dimensions indicated on Drawings, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.
1. Hanger Style: Match existing.
  2. Fabricate from the following materials:
    - a. Aluminum: 0.024 inch (0.61 mm) thick.
    - b. Galvanized Steel: 0.022 inch (0.56 mm) thick.

## 2.7 WALL SHEET METAL FABRICATIONS

- A. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings. Form head and sill flashing with 2-inch- (50-mm-) high, end dams. Fabricate from the following materials:
1. Aluminum: 0.032 inch (0.81 mm) thick.
  2. Galvanized Steel: 0.022 inch (0.56 mm) thick.
- B. Wall Expansion-Joint Cover: Fabricate from the following materials:

1. Aluminum: 0.040 inch (1.02 mm) thick.
2. Galvanized Steel: 0.028 inch (0.71 mm) thick.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION OF UNDERLAYMENT**

#### **A. Self-Adhering, High-Temperature Sheet Underlayment:**

1. Install self-adhering, high-temperature sheet underlayment; wrinkle free.
2. Prime substrate if recommended by underlayment manufacturer.
3. Comply with temperature restrictions of underlayment manufacturer for installation; use primer for installing underlayment at low temperatures.
4. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses.
5. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps and edges with roller.
6. Roll laps and edges with roller.
7. Cover underlayment within 14 days.

#### **B. Install slip sheet, wrinkle free, over underlayment before installing sheet metal flashing and trim.**

1. Install in shingle fashion to shed water.
2. Lap joints not less than 4 inches (100 mm).

### **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 and 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 (300 mm) o.c.
6. Space individual cleats not more than 12 inches (300 mm) 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.

- 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 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 (3 m) with no joints within 24 inches (600 mm) of corner or intersection.
  2. Form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
  3. Use lapped expansion joints only where indicated on Drawings.
- D. Fasteners: Use fastener sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. 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.
- F. 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 (25 mm) into sealant.
    - b. Form joints to completely conceal sealant.
    - c. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), 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 (4 deg C).
  2. Prepare joints and apply sealants to comply with requirements in Section 079200 "Joint Sealants."
- G. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter.
1. Pretin edges of sheets with solder to width of 1-1/2 inches (38 mm); however, reduce pretinning where pretinned surface would show in completed Work.
  2. Do not solder metallic-coated steel or aluminum sheet.
  3. Do not use torches for soldering.

4. Heat surfaces to receive solder, and flow solder into joint.
  - a. Fill joint completely.
  - b. Completely remove flux and spatter from exposed surfaces.

H. Rivets: Rivet joints where necessary for strength.

### 3.3 INSTALLATION OF ROOF-DRAINAGE SYSTEM

A. Install sheet metal roof-drainage items to produce complete roof-drainage system in accordance with cited sheet metal standard unless otherwise indicated. Modify existing roof perimeter flashing as needed for installation of roof-drainage system.

B. Hanging Gutters:

1. Provide full length sections without seams or joints between expansion joints.
2. Provide expansion joints as indicated for thermal expansion.
3. Attach gutters at eave or fascia to firmly anchor them in position.
4. Provide end closures and seal watertight with sealant.
5. Slope to downspouts.
6. Install gutter with expansion joints at locations indicated on Drawings, but not exceeding, 50 feet (15.2 m) apart. Install expansion-joint caps.

C. Downspouts:

1. Join sections with 1-1/2-inch (38-mm) telescoping joints.
2. Provide hangers with fasteners designed to hold downspouts securely to walls.
3. Locate hangers at top and bottom and at approximately 60 inches (1500 mm) o.c.
4. Provide elbows at base of downspout to direct water away from building.
5. Connect downspouts to underground drainage system.

D. Splash Pans:

1. Install where downspouts discharge on low-slope roofs.
2. Set in elastomeric sealant compatible with the substrate.

E. Expansion-Joint Covers: Install expansion-joint covers at locations and of configuration indicated on Drawings. Lap joints minimum of 4 inches (100 mm) in direction of water flow.

### 3.4 INSTALLATION OF ROOF FLASHINGS

A. Roof Edge Flashing:

1. Modify existing roof edge flashings as needed to install gutters and shed water.
2. Anchor to resist uplift and outward forces as needed.

B. Counterflashing: Coordinate installation of counterflashing with installation of base flashing.

1. Insert counterflashing in reglets or receivers and fit tightly to base flashing.

2. Extend counterflashing 4 inches (100 mm) over base flashing.
3. Lap counterflashing joints minimum of 4 inches (100 mm).

### 3.5 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.

### 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 (6 mm in 6 m) on slope and location lines indicated on Drawings and within 1/8-inch (3-mm) 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. 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.

**END OF SECTION 076200**

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## **SECTION 077200 - ROOF ACCESSORIES**

### **PART 1 - GENERAL**

#### **1.1 DESCRIPTION**

- A. Conditions of the Contract and Division 1 apply to this Section.
- B. Provide all labor, materials and equipment necessary to complete roof accessory work as indicated in the Contract Documents.

#### **1.2 RELATED WORK SPECIFIED ELSEWHERE**

- A. Section 076200 - Sheet Metal Flashing and Trim
- B. Section 079200 – Joint Sealants
- C. Drawings for related work associated with curb replacement.

#### **1.3 SUBMITTALS**

- A. Refer to Section 013300 for Submittal Requirements.
- B. Product Data: Submit manufacturer's descriptive literature for each type of roof accessory, including details of construction, materials, dimensions, preparation, anchoring, profiles, configurations and finishes.

#### **1.4 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. All materials delivered to the job site shall be in original packaging, sealed and labeled.
- B. Delivery, storage and handling shall be accomplished in such a manner so as to prevent damage to construction and finish of product.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- A. Custom Roof Curb Units
  - 1. Custom prefabricated retrofit metal building curb units designed to replace existing curb units or provide new curbs in existing standing seam roof systems.
    - a. Basis of Design: Thybar TC-3 MBD Retro Curb
  - 2. Custom fabricated in conformance to commercial quality specifications to fit existing roof slope, standing seam rib configuration and locations, and to match opening and provide support for existing rooftop equipment.
    - a. Existing equipment: (Field verify before fabrication)

- 1) Manufacturer/product: Greenheck Cube 420-50 20,000cfm belt-drive 5HP 485 rpm rooftop fan units (field verify before fabrication)
  - 2) Weight: Approximately 400# (field verify before fabrication).
  - 3) Curb opening: Field verify.
3. Pre-fabricated of Prime G-90 galvanized steel, minimum 18 gauge, with fully mitered and welded corners and formed-in integral water diverter (cricket).
  4. All continuous-welded construction with welds coated with aluminum colored urethane sealer.
  5. Curbs internally reinforced, and factory insulated with 1 ½" thick 3 lb. density fiberglass insulation. Height minimum 8" above plane of roof, top level with roof pitch built into the curbs. Size and profile to match existing opening, subframing and supported equipment.
  6. Perimeter flanges/base plate of width to properly match and seal to adjacent roof panels, pre-punched along perimeter edges for fasteners.
  7. Provide conforming notches in base plate and integral formed cell caps of size, profile and location to match and seal to existing standing seam roof panel ribs.
  8. Furnish curbs with manufacturer's installation materials including:
    - a. 2 ½" triple bead tape mastic
    - b. Urethane caulk
    - c. Self-drilling screws for flanges
    - d. Self-tapping screws for sides or tops of cell caps
    - e. ¾" tape mastic for base flanges of cell caps.
    - f. Manufacturer's installation instructions
    - g. Any other components required by manufacturer for proper waterproof installation.
  9. Roof curb units shall be supported by existing subframing but shall be installed to allow the curb to float during expansion and contraction of the roof panels. Roof curb and frame shall not pin the roof panel to the building structural system.

## **PART 3 - EXECUTION**

### **3.1 FIELD VERIFICATION**

- A. Field verify all pertinent existing conditions before ordering and fabrication, including:
  1. Size of curb openings
  2. Locations of and ends of existing roof panel ribs relative to each curb/opening
  3. Configuration of structural supports below curbs.
  4. Extent of existing curb flanges and fasteners.

### **3.2 INSPECTION**

- A. Beginning of installation shall signify acceptance of substrate and adjacent conditions as being proper and acceptable. Corrections of defects due to installation of products on unacceptable substrata will be at Contractor's expense at no additional cost to Owner.
- B. Completely remove existing curb, flashing and sealants. Clean and prepare surfaces per manufacturer for proper waterproof installation of new curb.

### 3.3    INSTALLATION

- A.    Fabricate only from approved shop drawings.
- B.    Install new curb units per manufacturer's written instructions and final shop drawings to provide a permanently sealed water-tight installation.
- C.    Install new curb unit to allow roof panels to properly float with thermal movement without pinning to structure.

### 3.4    ADJUST AND CLEAN

- A.    Adjust and check each operating item of hardware to ensure proper operation or function of every unit. Replace units which cannot be adjusted to operate freely and smoothly as intended for the application specified.
- B.    Clean-up premises of all litter, dirt, and debris created by work of this Section.

**END OF SECTION 077200**

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## **SECTION 079200 - 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. Latex joint sealants.

- B. Related Sections:

1. Section 088100 "Glass and Glazing" for glazing sealants.
2. Section P-605 FAA 10G "Joint Sealants for Concrete Pavements" for joint sealants for exterior pavements and aircraft aprons.
3. Section 077200 "Roof Accessories" for roof curb sealants.
4. Section 076200 "Sheet Metal Flashing and Trim" for other related sealants.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each joint-sealant product indicated.
- 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.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified Installer.
- B. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.
- C. Sealant, Waterproofing, and Restoration Institute (SWRI) Validation Certificate: For each sealant specified to be validated by SWRI's Sealant Validation Program.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.
- E. Warranties: Sample of special warranties.

#### **1.5 QUALITY ASSURANCE**

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

- B. Source Limitations: Obtain each kind of joint sealant from single source from single manufacturer.

#### 1.6 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 in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

#### 1.7 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 (5 deg C).
  - 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.

#### 1.8 WARRANTY

- A. Special Installer's Warranty: Manufacturer's standard form in which 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: 2 years from date of Substantial Completion.
- B. Manufacturer's Warranty: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
  - 1. Warranty Period: 2 years from date of Substantial Completion.
- C. Warranties specified in this article exclude deterioration or failure of joint sealants from the following:
  - 1. Movement of the structure caused by structural settlement or errors attributable to design or construction resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression.
  - 2. Disintegration of joint substrates from natural 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 PRODUCTS AND MANUFACTURERS**

- A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified. Manufacturers' names and products are given to clarify the designer's intent and are not intended to limit selection of similar products from acceptable manufacturers.

### **2.2 MATERIALS, GENERAL**

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer, based on testing and field experience.
- B. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- C. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- D. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

### **2.3 SILICONE JOINT SEALANTS**

- A. (JS-1) Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 50, for Use NT.
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. Dow Corning Corporation; 799.
  - b. Polymeric Systems, Inc.; PSI-631.
  - c. Pecora Corporation; 898
  - d. Tremco Incorporated; Tremsil 600.

### **2.4 URETHANE JOINT SEALANTS**

- A. (JS-2) Multicomponent, Nonsag, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 50, for Use NT, M, A, and O.
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. Pecora Corporation; Dynatrol II.
  - b. Polymeric Systems, Inc.; PSI-270.

- c. Tremco Incorporated; Dymeric 240.
- B. (JS-3) Multicomponent, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type M, Grade NS, Class 25, for Use NT, T, M, A, and O.
- 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. BASF Building Systems; Sonolastic NP 2.
    - b. Pecora Corporation; Dynatred.
    - c. Tremco Incorporated; Vulkem 227.

## 2.5 LATEX JOINT SEALANTS

- A. (JS-4) Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, mildew-resistant, ASTM C 834, Type OP, Grade NF.
- 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. BASF Building Systems; Sonolac.
    - b. Bostik, Inc.; Chem-Calk 600.
    - c. Pecora Corporation; AC-20+.
    - d. Schnee-Morehead, Inc.; SM 8200.
    - e. Tremco Incorporated; Tremflex 834.

## 2.6 JOINT SEALANT BACKING

- A. General: Provide sealant backings of material that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, Type C (closed-cell material with a surface skin) Type O (open-cell material, not for horizontal applications) Type B (bicellular material with a surface skin, not for horizontal applications) 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.

## 2.7 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.



- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## **PART 3 - EXECUTION**

### **3.1 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.
- 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.
    - d. Exterior insulation and finish systems.
  - 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. Glass.
    - c. Porcelain enamel.
    - d. 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. Do not install a different sealant type in applications
- C. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- D. 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.
- 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 C 1193, unless otherwise indicated.

### 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 (300 m) of joint length for each kind of sealant and joint substrate.
  2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
    - 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 passes 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 fill, 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 and remove 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: Interior joints in horizontal traffic surfaces. (JS-3)

1. Joint Locations:
  - a. Isolation and contraction joints in cast-in-place concrete slabs.
  - b. Control joints between concrete slabs and foundation walls, or other slab penetrations.
  - c. Joints between different materials listed above.
  - d. Other joints as indicated.
2. Urethane Joint Sealant: Multicomponent, nonsag, traffic grade, Class 25.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

#### B. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces. (JS-2)

1. Joint Locations:
  - a. Construction joints in cast-in-place concrete, non-traffic conditions.
  - b. Control and expansion joints in unit masonry.
  - c. Joints between metal panels, where indicated.
  - d. Joints at perimeter of aluminum storefront and window assemblies
  - e. Sealed joints associated with terra cotta rainscreen systems.
  - f. Joints between different materials listed above and at exterior wall penetrations through the above materials and assemblies.
  - g. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
  - h. Control and expansion joints in soffits and other overhead surfaces.
  - i. Other joints as indicated.
2. Urethane Joint Sealant: Multicomponent, nonsag,, Class 50.
3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

#### C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces (JS-1).

1. Joint Locations:
  - a. Control and expansion joints on exposed interior surfaces of exterior walls.
  - b. Perimeter joints of exterior openings where indicated.
  - c. Tile control and expansion joints.
  - d. Vertical joints on exposed surfaces of interior unit masonry walls and partitions.

- e. Perimeter joints between interior wall surfaces and frames of interior doors windows, and mechanical/electrical components.
    - f. Other joints as indicated.
  - 2. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 50.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces (JS-4).
- 1. Joint Sealant Location:
    - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
    - b. Other joints as indicated.
  - 2. Joint Sealant: Acrylic latex or siliconized acrylic latex.
  - 3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

**END OF SECTION 079200**

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## **SECTION 081100 - HOLLOW METAL DOORS AND FRAMES**

### **PART 1 - GENERAL**

#### **1.1 DESCRIPTION**

- A. Conditions of the Contract and Division 1 apply to this Section.
- B. Provide labor, materials, and equipment necessary to furnish hollow metal doors and frames as indicated in the Contract Documents.

#### **1.2 QUALITY ASSURANCE**

- A. Comply with all ASTM requirements and UL labeling. Comply with BHMA requirements and HMMA guide specifications. Labeled doors and frames shall have labels attached.
  - 1. HMMA 861 - Guide specifications for commercial hollow metal doors and frames.
- B. Fire-Rated Door Assemblies
  - 1. Provide units that comply with NFPA 80, are identical to door and frame assemblies whose fire resistance characteristics have been determined per ASTM E 152 and which are labeled and listed by UL, Factory Mutual, Warnock Hersey, or other testing and inspecting organization acceptable to authorities having jurisdiction.
  - 2. Provide factory installed labels on doors and frames.
- C. Oversize Fire-Rated Door Assemblies
  - 1. For units exceeding sizes of tested assemblies, provide manufacturer's certification that doors conform to all standard construction requirements of tested and labeled fire-rated door assemblies except for size.
- D. Regulatory Requirements
  - 1. Conform to applicable code for fire rated doors and panels.
- E. Reference Standards
  - 1. ASTM A 153 Spec. for Zinc Coating (Hot Dip) on Iron and Steel Hardware.
  - 2. ASTM A 366 Spec. for Steel, Carbon, Cold-Rolled Sheet, Commercial Quality.
  - 3. ASTM A 568 Spec. for Steel, Sheet, Carbon and High Strength, Low Alloy, Hot-Rolled, and Cold-Rolled.
  - 4. ASTM A 569 Spec. for Steel, Carbon (0.15 Max., Percent) Hot-Rolled Sheet, and Strip, Commercial Quality.
  - 5. NFPA 80 Fire Doors and Windows.
  - 6. ANSI A115 Specifications for Steel Door and Frame Preparation for Hardware.
  - 7. ANSI/SDI 100 Recommended Specifications for Standard Steel Doors and Frames.
  - 8. SDI 105 Recommended Erection Instructions for Steel Frames.

### 1.3 SUBMITTALS

- A. Refer to Division 1 for General Submittal Requirements.
- B. Product Data: Manufacturer's descriptive literature for each type of door and frame specified, including details of construction, materials, dimensions, hardware preparation, anchoring, core, label compliance, sound ratings, profiles, configurations and finishes.
- C. Shop Drawings
  - 1. Show fabrication and installation of steel doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of door and frame hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.
  - 2. Provide schedule of doors and frames using same reference numbers for details and openings as those on contract drawings.
  - 3. Indicate coordination of glazing frames and stops with glass and glazing requirements.
- D. Certificates: UL approvals.

### 1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Accomplish delivery, storage and handling of hollow metal work in a manner which prevents damage to construction and finish.
- B. Doors shall be stored in upright position in a protected and dry area with bottom edge placed on wood strips over the ground or floor and doors shimmed to provide at least 1/4 inch space between individual units for air circulation.
- C. Factory finished doors shall be individually packaged in cartons which will completely protect doors during shipping and handling. Protection consisting of polyethylene bags will not be acceptable.

## **PART 2 - PRODUCTS**

### 2.1 MATERIALS

- A. Acceptable Manufacturers
  - 1. Amweld Building Products
  - 2. Ceco Corporation
  - 3. Curries Company
  - 4. Republic Builders Products
  - 5. Steelcraft Manufacturing
- B. Hollow Metal Frames: HMMA 861
  - 1. Door and Borrowed Lite Frames:
    - a. Interior: 16 gauge.



- b. Exterior and Fire-Rated: 14 gauge, galvanized
2. Frames shall be hot rolled pickled and annealed steel. Manufacture frames to size shown on Door and Hardware Schedule x 5 3/4" deep (verify and match existing frames being replaced) with continuous full welded construction over the entire profile and fully mitered corners, with no unwelded seams or joints.
  3. Provide 14 gauge metal clip angle floor anchors. Provide removable spreader across frame bottom.
  4. Provide three (3) GJ No. 64 silencers per latch jamb for all interior door frames. At double doors without mullion, provide one (1) at head, each leaf. Provide non-penetrating adhered silencers at exterior doors.
  5. Anchors: Provide proper type of anchors required by wall conditions. Provide quantities as recommended by HMMA. Comply with U.L. requirements. Hot dipped galvanized anchors at masonry.
    - a. 3 anchors per jamb up to 86" high. Four anchors per jamb for doors over 86" high.
  6. Frames shall be complete with dust covers and mortar boxes.
  7. Borrowed light and sidelite frames shall have full length steel stops attached to frame with countersunk oval head tamperproof machine screws. Stops shall have tight fitting corners and hairline joints.
- C. Flush Hollow Metal Doors: HMMA 861
1. Doors shall be sizes as shown on drawings x 1-3/4" thickness.
    - a. Latch or lock edge of all hollow metal doors shall be beveled.
    - b. Interior Doors: 18 gauge
    - c. Exterior and Fire-Rated Doors: 16 gauge, galvanized.
  2. Standard doors shall be full welded construction with honeycomb core. Welds shall fill all spaces and be ground smooth. Allow no seams or gaps on any surface. Reinforced per BHMA and HMMA to accept specified hardware.
  3. Top of all exterior doors shall be completely closed with continuously welded closure to exclude all water; Open "U" top not acceptable.
  4. Exterior doors shall have "foamed-in-place" urethane insulation. Remainder of specifications similar to standard doors.
  5. Fire-rated doors shall be 16 gauge full flush welded construction and have UL acceptable Honeycomb or Kalamine core. Welds shall fill all spaces and be ground smooth. Allow no seams or gaps.
- D. Glazing Stops
1. Provide one removable stop and one fixed stop for glazed openings. Secure removable stop with countersunk, oval head, self-tapping screws at maximum spacing of 16 inch centers.
  2. Glazing stops shall be of design that will permit application of glazing sealant on each side of glass to the following minimum dimensions for the listed types of glass:
    - a. Monolithic glass - 1/8 inch clearance on each side.
    - b. Laminated and insulating glass - 3/16 inch on each side.

- E. Finishing: All hollow metals shall receive prime paint and shall be phosphatized prior to prime painting. Exterior hollow metals shall be galvanized prior to prime painting.
- F. Astragals
  - 1. Provide 1-3/4 inch by 12 gauge overlapping full height astragal welded on active leaf at pairs of exterior doors.
  - 2. Provide astragals as required by Underwriter's Label construction at pairs of interior label doors. Astragals shall be full height overlapping type applied on active leaf.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Fabricate only from approved shop drawings.
- B. Install steel doors, frames, and accessories per manufacturer's printed instructions, U.L. label requirements and in accordance with final shop drawings and as specified.
- C. Mortise, reinforce, drill and tap at factory for specified hardware. Reinforce frame on both sides so door closers or holders can be applied to either side.
- D. Door Clearances: 1/8 inch maximum at jambs and heads, 1/4 inch maximum at meeting stiles of pairs of doors (1/8 inch maximum on fire doors), 3/4 inch maximum between bottom of door and finished floor except where larger undercuts are scheduled or where thresholds require specific clearance.
- E. Fire Door Clearances: Install with clearances as specified in NFPA Standard No. 80. Undercut clearances greater than 3/4 inch are not permitted at single label doors and 3/8 inch at pair of label doors.
- F. Fully remove existing doors, frames and anchors and repair/prepare mounting surfaces as needed at doors to be replaced. Protect and salvage existing hardware and package together and label by door number. Install each new exterior frame, door and associated hardware on the same working day to maintain security.
- G. Frame Installation: Comply with provisions of SDI 105, unless otherwise indicated. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After installation is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged. Fully grout all hollow metal door frames installed in masonry wall construction.

### **3.2 ADJUST AND CLEAN**

- A. Prime Coat Touch-up: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touch-up of compatible air-drying primer.
- B. Protection Removal: Immediately prior to final inspection, remove protective plastic wrappings from prefinished doors.

- C. Final Adjustment: Check and readjust operating hardware items, leaving steel doors and frames undamaged and in complete proper operating condition.
- D. Clean premises of litter, dirt and debris created by work of this Section. Leave premises broom clean.

**END OF SECTION 081100**

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## **SECTION 087100 – 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.
  2. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
1. Mechanical door hardware.
  2. Electromechanical door hardware, to be reconnected to existing access control system.
- C. Related Sections:
1. Section 081100 – Hollow Metal Doors and Frames.
- 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 80 - Fire Doors and Windows.
  4. NFPA 101 - Life Safety Code.
  5. NFPA 105 - Installation of Smoke Door Assemblies.
  6. 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.
  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. 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.
- E. Warranties and Maintenance: Special warranties and maintenance agreements specified in this Section.

#### 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.
1. Scheduling Responsibility: Preparation of door hardware and keying schedules.
- D. Source Limitations: Obtain each type and variety of Door Hardware specified in this Section from a single source, qualified supplier unless otherwise indicated.
1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third-party source will not be accepted.
  2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise necessary and approved.
- E. Regulatory Requirements: Comply with NFPA 70, NFPA 80, NFPA 101 and ANSI A117.1 requirements and guidelines as directed in the model building code including, but not limited to, the following:
1. NFPA 70 "National Electrical Code", including electrical components, devices, and accessories listed and labeled as defined in Article 100 by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
  2. Comply with Americans with Disabilities Act (ADA), "Accessibility Guidelines for Buildings and Facilities (ADAAG)," ANSI A117.1 as follows:
    - a. Handles, Pulls, Latches, Locks, and other Operating Devices: Shape that is easy to grasp with one hand and does not require tight grasping, tight pinching, or twisting of the wrist.
    - b. Door Closers: Comply with the following maximum opening-force requirements indicated:
      - 1) Interior Hinged Doors: 5 lbf applied perpendicular to door.
      - 2) Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
    - c. Thresholds: Not more than 1/2 inch high. Bevel raised thresholds with a slope of not more than 1:2.
  3. NFPA 101: Comply with the following for means of egress doors:

- a. Latches, Locks, and Exit Devices: Not more than 15 lbf to release the latch. Locks shall not require the use of a key, tool, or special knowledge for operation.
  - b. Thresholds: Not more than 1/2 inch high.
- 4. Fire-Rated Door Assemblies: Provide door hardware for assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to NFPA 252 (neutral pressure at 40" above sill) or UL-10C.
  - a. Test Pressure: Positive pressure labeling.
- F. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.
- G. Keying Coordination: Coordinate with Owner to match existing keying.
- H. Pre-Installation Coordination: Coordinate timing and sequence of installation with door installations to maintain security requirements.
  - 1. Prior to installation of door hardware, arrange for manufacturers' representatives to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. 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
- I. At completion of installation, provide written documentation that components were applied per manufacturer's instructions and recommendations and according to approved schedule.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory existing door hardware on removal and label by door number before turning over to Owner. Inventory new hardware on receipt and provide secured storage for door hardware delivered to Project site.
- 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, and related accessories directly to Owner.



## 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 re-installation of existing access control devices and related interconnections on new doors and frames.
- C. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the re-installation of the electrified, monitoring, signaling and access control system devices and 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 new 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. 5 years for locks and latches.
  - 2. 5 years for exit hardware.
  - 3. 10 years for manual door closers.
  - 4. 2 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.

- B. Continuing Service: Beginning at Substantial Completion, and running concurrent with the specified warranty period, provide continuous (6) months full maintenance including repair and replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper door opening operation. Provide parts and supplies as used in the manufacture and installation of original products.

## **PART 2 - PRODUCTS**

### **2.1 HANGING DEVICES**

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles as specified in the Door Hardware Sets.
1. Quantity: Provide the following hinge quantity, unless 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, unless otherwise indicated, 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" standard or heavy weight as specified.
  3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
    - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing hinges.
    - b. Interior Doors: Heavy weight, non-ferrous, ball bearing hinges.
  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 following applications:
      - 1) Out-swinging exterior doors.
      - 2) Out-swinging access controlled doors.
      - 3) Out-swinging lockable doors.
  5. Acceptable Manufacturers:
    - a. Hager Companies (HA).
    - b. McKinney Products (MK).
    - c. Stanley Hardware (ST).

## 2.2 DOOR OPERATING TRIM

- A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified automatic, self-latching, and manual flush bolts and surface bolts. Manual flush bolts to be furnished with top rod of sufficient length to allow bolt location approximately six feet from the floor. Furnish dust proof strikes for bottom bolts. 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. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
1. Acceptable Manufacturers:
    - a. Door Controls International (DC).
    - b. Rockwood Manufacturing (RO).
    - c. Trimco (TC).
- B. Coordinators: ANSI/BHMA A156.3 certified door coordinators consisting of active-leaf, hold-open lever and inactive-leaf release trigger. Coordinators fabricated from steel with nylon-coated strike plates and built-in adjustable safety release.
1. Acceptable Manufacturers:
    - a. Door Controls International (DC).
    - b. Rockwood Manufacturing (RO).
    - c. Trimco (TC).
- C. Door Push Plates and Pulls: ANS/BHMA A156.6 certified door pushes and pulls of type and design specified below or 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, 4-inches wide by 16-inches high, with square corners and beveled edges, secured with exposed screws unless otherwise indicated.
  2. Straight Pull Design: Minimum 1-inch round diameter stainless steel bar or tube stock pulls with 2 1/2-inch projection from face of door unless otherwise indicated.
  3. Offset Pull Design: Minimum 1-inch round diameter stainless steel bar or tube stock pulls with 2 1/2-inch projection and offset of 90 degrees unless otherwise indicated.
  4. Push Bars: Minimum 1-inch round diameter horizontal push bars with minimum clearance of 2 1/2-inch projection from face of door unless otherwise indicated.
  5. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
    - a. Acceptable Manufacturers:
      - 1) Hiawatha, Inc. (HI).
      - 2) Rockwood Manufacturing (RO).
      - 3) Trimco (TC).

## 2.3 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. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.
  - 1. Acceptable Manufacturers:
    - a. Match existing (No Substitution.)
- C. Cylinders: Original manufacturer cylinders to match existing, complying with the following:
  - 1. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
  - 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.
- D. Permanent Cores: Match existing cores and keying system; finish face to match lockset; complying with the following:
  - 1. Removable Cores: Core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware. Provide removable core (small or large format) to match existing.
- E. Keying System: Each type of lock and cylinders to be factory keyed. Coordinate with Owner to define and document keying system instructions and requirements. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
- F. Key Quantity: Provide the following minimum number of keys:
  - 1. Top Master Key: One (1)
  - 2. Change Keys per Cylinder: Two (2)
  - 3. Master Keys (per Master Key Group): Two (2)
  - 4. Grand Master Keys (per Grand Master Key Group): Two (2)
  - 5. Construction Control Keys (where required): Two (2)
  - 6. Permanent Control Keys (where required): Two (2)
- G. Construction Keying: Not required. Provide permanent cores keyed to existing at time of installation.

## 2.4 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets: ANSI/BHMA A156.13, Operational Grade 1 (Heavy duty), certified mortise locksets furnished in the functions as specified in the Hardware Sets. All

functions shall be manufactured in a single sized case formed from 12 gauge steel minimum. The lockset shall have a field-adjustable, beveled armored front, with a .125" minimum thickness and shall be reversible without opening the lock body. The lockset shall be 2 3/4" backset with a one-piece 3/4" anti-friction stainless steel latchbolt. The deadbolt shall be a full 1" throw made of stainless steel. All strikes shall be non-handed with a curved lip. All locks shall be provided with strike boxes. To insure proper alignment, all trim, shall be thru-bolted and fully interchangeable between rose and escutcheon designs.

1. Acceptable Manufacturers:
  - a. Match Existing (No substitutions)

B. Lock Trim Design: Match existing.

## 2.5 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.

B. Standards: Comply with the following:

1. Strikes for Bored Locks and Latches: BHMA A156.2.
2. Strikes for Auxiliary Deadlocks: BHMA A156.5.
3. Dustproof Strikes: BHMA A156.16.

## 2.6 CONVENTIONAL EXIT DEVICES

A. 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. Mounting rails to be formed from smooth stainless steel, brass or bronze architectural materials no less than 0.072" thick, with push rails a minimum of 0.062" thickness. Painted or aluminum metal rails are not acceptable. Exit device latch to be investment cast stainless steel, pullman type, with deadlock feature. Lever trim to match existing where scheduled.

1. Acceptable Manufacturers:
  - a. Von Duprin (VD)
  - b. Sargent Manufacturing (SA)
  - c. Precision (PR)

## 2.7 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 and UBC 7-2 for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
  3. 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.
  4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
    - a. Where closers are indicated to have mechanical dead-stop, provide heavy duty arms and brackets with an integral positive stop.
    - b. Where closers are indicated to have mechanical hold open, provide heavy duty units with an additional built-in mechanical holder assembly designed to hold open against normal wind and traffic conditions. Holder to be manually selectable to on-off position.
    - c. Where closers are indicated to have a cushion-type stop, provide heavy duty arms and brackets with spring stop mechanism to cushion door when opened to maximum degree.
    - d. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics. Provide drop plates or other accessories as required for proper mounting.
  5. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates, and through-bolt or security type fasteners as needed to accommodate hardware specified in the door Hardware Sets.
- 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 body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control. Provide non-handed units and high impact, non-corrosive plastic covers standard.
1. Acceptable Manufacturers:
    - a. LCN (LCN) – 4040XP Series.
    - b. Stanley K2 (ST) – QDC100 Series.
    - c. Norton 7500 Series
    - d. Yale 4400 Series

## 2.8 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 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. Metal Protection Plates: ANSI/BHMA A156.6 certified metal protection plates (kick, armor, or mop), beveled on four edges (B4E), fabricated from the following.
  - a. Stainless Steel: .050-inch thick, with countersunk screw holes (CSK).
4. Fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets.
5. Metal Door Edging: Door protection edging fabricated from a minimum .050-inch thick metal sheet, formed into an angle or "U" cap shapes, surface or mortised mounted onto edge of door. Provide appropriate leg overlap to account for protection plates as required. Height to be as specified in the Hardware Sets.
6. Acceptable Manufacturers:
  - a. Hiawatha, Inc. (HI).
  - b. Rockwood Manufacturing (RO).
  - c. Trimco (TC).

## 2.9 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. Acceptable Manufacturers:
    - a. Rockwood Manufacturing (RO).
    - b. Trimco (TC).
    - c. Hiawatha, Inc. (HI).
- 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. Acceptable Manufacturers:
    - a. Architectural Builders Hardware (ABH).
    - b. Rockwood Manufacturing (RO).
    - c. Sargent Manufacturing (SA).

## 2.10 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 and as otherwise scheduled.
- C. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- D. Thresholds: Not less than 4" wide, ADA compliant, formed to accommodate change in floor elevation, fabricated to accommodate door hardware and to fit door frames.
- E. Acceptable Manufacturers:
  - 1. Pemko Manufacturing (PE).
  - 2. National Guard (NG).
  - 3. Reese Enterprises, Inc. (RS).

## 2.11 SILENCERS

- A. Furnish rubber door silencers equal to Rockwood 608 for all new interior hollow metal frames, two (2) per pair and three (3) per single door frame up to 7' 6" and one additional for every 30" in door height.

## 2.12 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.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Field verify existing hardware to properly match new hardware as indicated.
- B. Inspect doors and frames for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.



- C. 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.

### 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. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
- 3. 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 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.

- F. Reinstall all existing access control devices and connections on doors being replaced, unless noted otherwise, including door position switches and electric strike connections.

### 3.4 FIELD QUALITY CONTROL

- A. Field Inspection: Supplier shall 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. 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, and 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 SCHEDULE

- 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. Manufacturer's Abbreviations:
  - 1. AD - Adams Rite
  - 2. ABH – Architectural Builders Hardware Mfg.
  - 3. BE - Stanley Security Solutions Inc (Best)
  - 4. BY – By Others
  - 5. LCN – LCN
  - 6. MC – McKinney
  - 7. NO - Norton
  - 8. PE – Pemko
  - 9. RX - Rixson
  - 10. RO - Rockwood
  - 11. ST - Stanley
  - 12. SA - Sargent
  - 13. VD – Von Duprin

## Hardware Schedule

### Set 7.1: (Door 110) 3-hour rated

3	Hinges	FBB199 4-1/2" x 4-1/2" x NRP	US32D	ST
1	Closer (no hold-open)	4040XP EDA	ALUM	LCN
1	Mortise Lever Lockset	Match existing mfr/function/trim/key	US26D	
1	Threshold	252x3 AFG		PE
1	Weatherstrip	2891 AS (head)		PE
2	Weatherstrip	290 AS (jambs)		PE
1	Sweep	315 CN		PE

### Set 10.1: (Doors 123A, 127A, 129A) 3-hour rated

6	Hinges	FBB199 4-1/2" x 4-1/2" x NRP	US32D	ST
2	Closer (no hold open)	4040XP EDA	ALUM	LCN
1	Mortise Lever Lockset	Match existing mfr/function/trim/key	US26D	
1	Door Coordinator	1672 X MTG BKTS	US26D	RO
1	Set Automatic Flush Bolts	2842	US26D	RO
1	Dust Proof Strike	570	US26D	RO
1	Overlapping Astragal	by door manufacturer		

#### Door 123A only:

1	Threshold	252x3 AFG		PE
1	Weatherstrip	2891 AS (head)		PE
2	Weatherstrip	290 AS (jambs)		PE
1	Sweep	315 CN		PE
1	Meeting Stile / Astragal Seal	S772 D		PE

### Set 11.1: (Doors 123B, 127B, 129B, 131A, 131B, S1B and S2B)

3	Hinges	FBB199 4-1/2" x 4-1/2" x NRP	US32D	ST
1	Closer	4040XP EDA	ALUM	LCN
1	Overhead Stop, surface mounted	9000RA Series	US32D	ABH
1	Mortise Exit Device	8900-exit only/no trim (verify/match existing trim & function)	26D	SA
1	Latch Guard	320 series	US32D	RO

1	Threshold	252x3 AFG		PE
1	Weatherstrip	2891 AS (head)		PE
2	Weatherstrip	290 AS (jamb)		PE
1	Sweep	315 CN		PE
1	Rain Drip	346 C		PE

Doors 131A and 131B only:

1	Electric strike	Match existing		
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Door 131B only:

1	Door viewer	622	STNN	RO
1	Exterior Pull – Fixed	Fixed handle exit device trim	26D	

**Set 12.1: (Door 130)**

6	Hinges	FBB199 4-1/2" x 4-1/2" x NRP	US32D	ST
2	Overhead Stop, surface mounted	9000RA Series	US32D	ABH
1	Mortise Lever Lockset	Match existing mfr/function/trim/key	US26D	
2	Surface bolts (inactive leaf)	580-8	US32D	RO
1	Threshold	252x3 AFG		PE
1	Weatherstrip	2891 AS (head)		PE
2	Weatherstrip	290 AS (jamb)		PE
1	Sweep	315 CN		PE
1	Rain Drip	346 C		PE
1	Meeting Stile / Astragal Seal	S772 D		PE
1	Overlapping Astragal	by door manufacturer		

**Set 14.1: (Door S2A) 3-hour rated**

3	Hinges	FBB199 4-1/2" x 4-1/2" x NRP	US32D	ST
1	Closer (no hold open)	4040XP EDA	ALUM	LCN
1	Mortise Exit Device	8900-ET Trim (verify/match existing trim & function)	26D	SA

**END OF SECTION 087100**

## **SECTION 088100 - GLASS AND GLAZING**

### **PART 1 - GENERAL**

#### **1.1 DESCRIPTION**

- A. Conditions of the Contract and Division 1 apply to this Section.
- B. Provide all labor, materials, and equipment to complete glass and glazing work as indicated in the Contract Documents.
- C. Restore all failed or missing glazing at all exterior windows (Work Item WI-27).
- D. Provide sealed double pane windows to match makeup of existing units to replace hangar door windows (Work Item WI- 34).

#### **1.2 QUALITY ASSURANCE**

- A. Performance Standards
  - 1. Watertight and airtight installation of each glass product is required, except as otherwise shown. Each installation must withstand normal temperature changes, wind loading, impact loading (for operating sash and doors), without failure including loss or breakage of glass, failure of sealants or gaskets to remain airtight and watertight, deterioration of glazing materials and other defects in the work.
  - 2. Comply with combined recommendations and technical reports by manufacturers of glass and glazing products as used in each glazing channel and with recommendations of Flat Glass Marketing Association, "Glazing Manual", except where more stringent requirements are indicated.
  - 3. Install insulating glass units to comply with recommendations by Sealed Insulating Glass Manufacturer's Association, except as otherwise specifically indicated or recommended by glass and sealant manufacturers.

#### **1.3 SUBMITTALS**

- A. Refer to Division1 for General Submittal Requirements.
- B. Product Data: Submit catalog cuts and product data for all proposed products and materials.

#### **1.4 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. Delivery, storage and handling shall be accomplished in such a manner so as to prevent damage to construction and finish of product.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- A. The following are minimum requirements for various glazing products as may be applicable.
- B. Tempered Glazing
  - 1. Tempered Glass: PPG Herculite Clear Tempered Float Glass, minimum 1/4" thick, horizontally temper without tong marks.
- C. Exterior Insulated Glazing
  - 1. Low-E-Coated Insulating Glass: Provide 2 sheets of glass and a desiccant dehydrated gas filled space (3/8" unless otherwise noted) with -20 degree F (29 degrees C) dewpoint, with Class A sealant type edge construction to maintain a hermetic seal; fabricated to provide the following overall performance characteristics:
    - a. Exterior Glass, Insulated Units: Tinted float glass, Quality q3, 3/8" thick.
      - 1) Tint: TBD
    - b. Interior Glass: Clear, float glass, Quality q3, 1/4" thick.
    - c. Edge Construction: Twin primary seals of polyisobutylene; tubular aluminum or galvanized steel spacer bar frame with welded or soldered sealed corners and filled with desiccant; and secondary seal outside of bar, bonded to both sheets of glass and bar, of polysulfide, silicone or hot-melt butyl elastomeric sealant (fabricator's option).
    - d. Provide low-e coating: Pyrolitic on second surface.
    - e. Warranty: Provide manufacturer's standard 10 year product warranty on maintained hermetic seal.
- D. Exterior Insulated Tempered Glazing:
  - 1. Low-E-Coated, Tempered Insulating Glass: Provide 2 sheets of glass and a desiccant dehydrated gas filled space (3/8" unless otherwise noted) with -20 degree F (29 degrees C) dewpoint, with Class A sealant type edge construction to maintain a hermetic seal; fabricated to provide the following overall performance characteristics:
    - a. Exterior Glass, Insulated Units: Tinted, tempered glass, Quality q3, 3/8" thick.
      - 1) Tint: TBD
    - b. Interior Glass: Clear, tempered float glass, Quality q3, 1/4" thick.
    - c. Edge Construction: Twin primary seals of polyisobutylene; tubular aluminum or galvanized steel spacer bar frame with welded or soldered sealed corners and filled with desiccant; and secondary seal outside of bar, bonded to both sheets of glass and bar, of polysulfide, silicone or hot-melt butyl elastomeric sealant (fabricator's option).
    - d. Provide low-e coating: Pyrolitic on second surface.

- e. Warranty: Provide manufacturer's standard 10 year product warranty on maintained hermetic seal.

E. Glazing Sealants and Components

- 1. Comply with manufacturer's recommendations for selection of hardness, depending upon the location of each application, conditions at time of installation, and performance requirements as indicated. Select materials (and variation or modifications) carefully for compatibility with existing remaining glazing materials and surfaces contacted in the installation.

## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. Verify prepared openings and frames are in accordance with recommendations of glazing manufacturer.
- B. Verify that new glazing units are correctly sized and within recommended tolerances.
- C. Verify that surfaces of glazing channels and recesses are clean, free of obstructions and old glazing materials and ready to receive glazing materials.
- D. Beginning of installation constitutes acceptance of substrate.

### **3.2 INSTALLATION**

- A. Clean glazing channel and other framing members to receive glass immediately before glazing. Remove coatings which are not firmly bonded to substrate. Remove lacquer from metal surfaces where elastomeric sealants are used.
- B. Apply primer or sealant to joint surfaces where recommended by sealant manufacturer.
- C. Install setting block of proper size in sill rabbet, located 1/4 of glass width from each corner. Set blocks in thin course of heel-bead compound, if any.
- D. Provide spacers inside and out, of proper size and spacing, for glass sizes larger than 50 united inches, except where gaskets or preshimmed tapes are used for glazing. Provide 1/8" minimum bite of spacers on glass and use thickness equal to sealant width, except with sealant tape use thickness slightly less than final compressed thickness of tape.
- E. Set units of glass in each series with uniformity of pattern, draw, bow, and similar characteristics.
- F. Voids and Filler Rods: Prevent exudation of sealant or compound by forming voids or installing filler rods in channel at heel of jambs and head (do not leave voids in still channels), except as otherwise indicated and depending on light size, thickness, and type of glass and complying with manufacture's recommendations.

- G. Force sealants into channel to eliminate voids and to ensure complete "wetting" or bond of sealant to glass and channel surfaces.
- H. Tool exposed surfaces of glazing liquids and compounds to provide a substantial "wash" away from glass. Install pressurized tapes and gaskets to protrude slightly out of channel, so as to eliminate dirt and moisture pockets.
- I. Clean and trim excess glazing materials from glass and stops or frames promptly after installation to eliminate stains and discolorations.
- J. Where wedge shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage to ensure that gasket will not "walk" out when installation is subjected to movement. Anchor gasket to stop with matching ribs or by proven adhesives, including embedment of gasket tail in cured heel bead.
- K. Gasket Glazing: Miter cut and bond ends together at corners where gaskets are used for channel glazing, so that gaskets will not pull away from corners and result in voids or leaks in glazing system.
- L. Structural Gasket Glazing: Cut zipper strips slightly long, to ensure tight closure. Lubricate zipper strip and use special tool to install zipper. Do not lubricate glazing channel or anchorage rabbet. Comply with details as shown and manufacturer's instructions, including the possible use of liquid sealants and weep holes.

### 3.3 ADJUST AND CLEAN

- A. Do not apply markers to surfaces of glass. Remove nonpermanent labels and clean surfaces. Cure sealants for high early strength and durability.
- B. Remove and replace glass which is broken, chipped, cracked, abraded or damaged in other ways during construction period, including natural causes, accidents and vandalism.
- C. Wash and polish glass on both faces. Comply with glass product manufacturer's recommendations for final cleaning.
- D. Clean premises of all litter, dirt, and debris created by work of this Section. Leave premises broom clean.

**END OF SECTION 088100**



## **SECTION 092216 - 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 Specifications Sections, apply to this Section.
- B. All Sections listed in the Table of Contents shall be related to this Work.

#### **1.2 SUMMARY**

- A. This Section includes non-load-bearing steel framing members for the following applications:
  - 1. Interior framing systems (e.g., steel studs for interior walls, furring).

#### **1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Steel Stud Work: Engineer design submittals

#### **1.4 QUALITY ASSURANCE**

- A. Fire-Test-Response Characteristics: For fire-resistance-rated assemblies that incorporate non-load-bearing steel framing, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.

### **PART 2 - PRODUCTS**

#### **2.1 NON-LOAD-BEARING STEEL FRAMING, GENERAL**

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
  - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
  - 2. Protective Coating: manufacturer's standard corrosion-resistant zinc coating, unless otherwise indicated.

#### **2.2 STEEL FRAMING FOR FRAMED ASSEMBLIES**

- A. Steel Studs and Runners: ASTM C 645.
  - 1. Minimum Base-Metal Thickness: 0.027 inch (0.7 mm), unless indicated otherwise.

- B. Deflection/slip head track: Manufacturers recommended product to accommodate vertical deflection of structure above top of wall.
- C. Cold-Rolled Furring Channels: 0.0538-inch (1.37-mm) bare-steel thickness, with minimum 1/2-inch- (12.7-mm-) wide flanges.
  - 1. Depth: As indicated on Drawings
  - 2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare-steel thickness of 0.0312 inch (0.79 mm).
  - 3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch- (1.59-mm-) diameter wire, or double strand of 0.0475-inch- (1.21-mm-) diameter wire.

### 2.3 AUXILIARY MATERIALS

- A. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power and other properties required to fasten steel members to substrates.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754.
  - 1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

### 3.2 INSTALLING FRAMED ASSEMBLIES

- A. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.
- B. Install tracks (runners) at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings, except where partitions are indicated to terminate at suspended ceilings. Continue framing around ducts penetrating partitions above ceiling.
  - 1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
  - 2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install runner track section (for cripple studs) at head and secure to jamb studs.
    - a. Install two studs at each jamb, unless otherwise indicated.
    - b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch (12.7-mm) 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.
- C. Direct Furring:
1. Attach to concrete or masonry with power-driven fasteners spaced 24 inches (610 mm) o.c.
- D. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch (3 mm) from the plane formed by faces of adjacent framing.

**END OF SECTION 092216**

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## **SECTION 092900 - 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. This Section includes the following as may be applicable to the work:
  - 1. Interior gypsum board.
  - 2. Exterior gypsum board.
  - 3. Tile backer panels.
  - 4. Trim Accessories and Auxiliary Materials

#### **1.3 SUBMITTALS**

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

#### **1.4 STORAGE AND HANDLING**

- A. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

#### **1.5 PROJECT CONDITIONS**

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent, including the application of control joints.
- B. Do not install interior products until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, those that are moisture damaged, and those that are 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 PANELS, GENERAL**

- A. Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

## 2.2 INTERIOR GYPSUM BOARD

- A. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.
- B. Standard/Regular Type:
  - 1. Thickness: 5/8 inch (15.9 mm), Type X
  - 2. Long Edges: Tapered.
- C. Type X, Abuse-Resistant & Moisture - and Mold-Resistant Type: Manufactured to produce greater resistance to surface indentation and through-penetration (impact resistance) than standard, regular-type and Type X gypsum board with a moisture- and mold-resistant core and surface.
  - 1. Basis of Design: USG; Sheetrock Gypsum Panels – Mold Tough AR Regular and Firecode Core.
  - 2. Thickness: 5/8 inch (15.9 mm), Type X
  - 3. Long Edges: Tapered
- D. Noise-Reducing Type: Intended to reduce sound transition through walls.
  - 1. Basis of Design: Certaineed: SilentFX.
  - 2. Thickness: 5/8 inch (15.9 mm), Type X.
  - 3. Long Edges: Tapered
  - 4. Comply with ASTM C 1396, 1629
- E. Ceiling Type: Manufactured to have more sag resistance than regular-type gypsum board.
  - 1. Thickness: 5/8 inch (12.7 mm).
  - 2. Long Edges: Tapered.

## 2.3 EXTERIOR GYPSUM BOARD

- A. Fiberglass–Matt faced, Water-Resistant Gypsum Board: ASTM C 1177/1177M, with manufacturer's standard edges.
  - 1. Basis of Design:
    - a. Georgia-Pacific Gypsum LLC; DensGlass Sheathing
  - 2. Core: 5/8 inch, Type X, water-resistant.
  - 3. Mold-resistance: ASTM D 3273, score of 10

## 2.4 TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Board: ASTM C 1178/C 1178M, with manufacturer's standard edges.
  - 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. CertainTeed Corp.; GlasRoc Tile Backer.
  - b. Georgia-Pacific Gypsum LLC; DensShield Tile Backer.
2. Core: 5/8 inch (15.9 mm), Type X.
  3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

## 2.5 TRIM ACCESSORIES

- A. Interior Trim: ASTM C 1047.
  1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
  2. Shapes:
    - a. Cornerbead.
    - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
    - c. Expansion (control) joint.

## 2.6 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C 475/C 475M.
- B. Joint Tape:
  1. Interior Gypsum Wallboard: Paper.
  2. Exterior Gypsum Wallboard: Self-Adhering glass-fiber tape, minimum 2" wide, recommended by tape and sheathing manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing.
- C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.
  1. Prefilling: At open joints, 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.

## 2.7 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

- C. Steel Drill Screws: ASTM C 1002, unless otherwise indicated.
  - 1. Use screws complying with ASTM C 954 for fastening panels to steel members from 0.033 to 0.112 inch (0.84 to 2.84 mm) thick.
- D. Acoustical Sealant: As specified in Division 07 Section "Joint Sealants."

## 2.8 FINISHES

- A. Smooth finish.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.
- 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 PANELS, GENERAL

- A. Comply with ASTM C 840.
- 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 (1.5 mm) 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.
- 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. (0.7 sq. m) 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- (6.4- to 9.5-mm-) wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- (6.4- to 12.7-mm-) wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- 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.

### 3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
1. Type X, Abuse Resistant, and Moisture- and Mold-Resistant Type: Typical vertical surfaces up to a height of 8'-0", unless otherwise indicated.
  2. Type X, Standard/Regular Type: Typical vertical surfaces above a height of 8'-0" (and in all above-ceiling concealed locations).
  3. Ceiling Type: Ceiling surfaces.
- 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 high walls, install panels horizontally, unless otherwise indicated or required by fire-resistance-rated assembly.
  3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
  4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

### 3.4 APPLYING EXTERIOR GYPSUM BOARD

- A. Fiberglass–Matt faced, Water-Resistant Gypsum Board: Install at exterior wall locations; and other locations where 'exterior' panels are indicated. Comply with manufacturer's written installation instructions and install at locations indicated to receive self-adhering or liquid applied air/moisture barriers. Install with 1/4-inch (6.4-mm) gap where panels abut other construction or penetrations.
- B. Where exterior gypsum panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

### 3.5 APPLYING TILE BACKING PANELS

- A. Glass-Mat, Water-Resistant Backing Panels: Install at all tiled wall locations; and elsewhere panels will be exposed to water. Comply with manufacturer's written installation instructions and install at locations indicated to receive tile. Install with 1/4-inch (6.4-mm) 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.

### 3.6 CONSTRUCTION AND CONTROL JOINTS

- A. For interior installations, allow a maximum of 30 linear feet between control joints. A control joint must be installed but not limited to the following locations: where expansion joints occur in the framing or building (discontinue all cross furring members located behind joint); when boards abut dissimilar materials; where framing material changes; at changes at building shape or structural system; at each story separation. Place control joints at corners of window and door openings, or follow specifications of architect.
- B. Coordinate and provide additional framing and furring members at joint locations to provide full support of panels on each side of joint.
- C. Control Joint: Extruded vinyl formed with V shaped slot covered with removable flexible vinyl strip and complying with ASTM C 1047.

### 3.7 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect for visual effect with the following additional criteria:
  - 1. Every 30 feet of partition run.
  - 2. Vertical intersection with construction changes within the plane of the wall such as T and L intersections.
  - 3. Expansion or control joints that occur through the building itself.
- C. Interior Trim: Install in the following locations:
  - 1. Cornerbead: Use at outside corners.
  - 2. LC-Bead: Use at exposed panel edges.

### 3.8 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, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
  - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
  - 2. Level 5: At all wall and ceiling surfaces to be painted, with smooth texture.

### **3.9 PROTECTION**

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, and mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

**END OF SECTION 092900**

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## **SECTION 096513 - RESILIENT BASE**

### **PART 1 - GENERAL**

#### **1.1 DESCRIPTION**

- A. Conditions of the Contract and Division 1 apply to this Section.
- B. Supply and install, complete in place, all resilient base work as indicated in the Contract Documents.

#### **1.2 QUALITY ASSURANCE**

- A. Resilient base installer shall have a minimum five (5) years experience and minimum three (3) projects installing the specified materials. Installer shall be approved by the manufacturer.
- B. All materials shall be from manufacturer's same batch lot or run.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Fire Test Data: ASTM E648, critical radiant flux 0.45 watts/cm<sup>2</sup>
- B. Smoke Development: ASTM E662 NBS smoke 450 or less.

#### **1.4 SUBMITTALS**

- A. Refer to Section 013300 for Submittal Requirements.
- B. Maintenance Data: Submit to Owner two copies of the manufacturer's recommendations regarding maintenance, stain removal, care, cleaning, waxing and polishing of resilient base. Also include recommendations and precautions regarding protection of floor against indentation caused by concentrated loading.
- C. Samples: Two (2) 6" long base and transition strips of each color specified in the Contract Documents.

#### **1.5 EXTRA MATERIALS**

- A. Leave with Owner 2% of each color, shape of each base used.
- B. Store in carton in area directed by Architect/Engineer.

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

- A. Deliver materials to job site in manufacturer's original, unopened packaging and adequately protect against damage while stored in dry and heated location at the site. Maintain minimum temperature at 65°F.

- B. Do not deliver materials to job site until conditions are prepared for installation of materials. Materials shall be in same environmental condition as space installed for minimum of 24 hours.
- C. Remove all damaged and unsuitable material from the job site immediately.

### 1.7 ENVIRONMENTAL CONDITIONS

- A. Protect adjoining work surfaces before the work begins.
- B. Maintain minimum temperature of 65°F and maximum temperature of 80°F 48 hours prior to, during and after installation of materials. Maintain minimum temperature of 55°F thereafter.

## **PART 2 - PRODUCTS**

### 2.1 MATERIALS

- A. RB1: Rubber Base:
  - 1. Accepted Manufacturers: See Finish Schedule for manufacturer Basis of Design.
    - a. Johnsonite
    - b. Armstrong World Industries'
    - c. Burke Mercer Flooring
    - d. Flexco, Inc.
    - e. Roppe Corp.
    - f. VPI
    - g. Musson
    - h. Substitutions: allowed in accordance with Division 1 and General Conditions.
  - 2. Premolded inside, outside corners and end stops.
  - 3. Coved base.
  - 4. Color as selected by Architect from manufacturer's standards.
- B. Transition strips shall be provided from same manufacturer as rubber base. Provide at all transitions to other materials and as indicated on Drawings.
- C. Primers and Adhesives: Use only materials recommended and approved by the base manufacturers.

## **PART 3 - EXECUTION**

### 3.1 INSPECTION

- A. Examine all subsurfaces to receive the work and report in writing to General Contractor, with copy to Architect/Engineer, any detrimental conditions. Failure to observe this injunction constitutes a waiver to any subsequent claims to the contrary and holds

resilient flooring Contractor responsible for any corrections Architect/Engineer may require. Commencement of the work will be construed as acceptance of all subsurfaces.

- B. Coordinate required surface corrections with Contractor responsible for installation.

### 3.2 INSTALLATION

#### A. General

1. Remove all paint, oils, waxes, sealers, and curing compounds not compatible with the adhesives employed. Organic solvents are to be avoided.
2. The adhesive manufacturer's directions for mixing and applying adhesive shall be followed. The surface shall be covered evenly with adhesive.
3. The area covered by one application of adhesive shall not exceed the maximum working area recommended by the manufacturer. Base shall be installed within the time limits recommended by the manufacturer. If adhesive film dries, it shall be removed and the area shall be recoated.

#### B. Layout (Base)

1. Install per manufacturer's written instructions and recommendations.
2. Apply base in one (1) piece as much as possible. Base shall be not less than 48" long any piece within a run.
3. Apply base to walls, columns, pilasters, casework and other permanent fixtures in rooms or areas where vinyl base is scheduled.
4. All materials shall be set straight and level in full bed of adhesive with tight flush butt joints and lower edge fit tightly against flooring. Scribe accurately to trim and door frames.
5. Internal corners shall be butted and coped to provide tight hairline joints.
6. External corners will be premolded. Field formed external corners from lineal base will not be permitted.

### 3.3 PROTECTION

- A. Work shall not be started until floor installation work of other trades has been completed.
- B. Traffic near or against installed base shall be minimized. Where traffic is unavoidable, protect with non-staining waterproof paper or other approved covering firmly fastened to floor surfaces.

### 3.4 ADJUST AND CLEAN

- A. Remove spots and smears of adhesive immediately from exposed surfaces. Clean surface with neutral cleaner of type and as recommended by tile manufacturer so as to remove excess cement, discoloration and show marks.
- B. After installation clean and rinse the base with clear, clean water. Use no acids or caustic solutions for cleaning.
- C. Near completion of the project and when directed by Architect/Engineer, remove paper, clean and buff base per manufacturer's printed instructions.

- D. Waxing shall be by Owner.
- E. Clean premises of all litter, dirt and debris created by work at this Section. Leave premises broom clean.

**END OF SECTION 096513**



## **SECTION 096519 - RESILIENT TILE 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. Luxury Vinyl floor tile.

#### **1.3 RELATED SECTIONS**

- A. Section 096513 "Resilient Base" for resilient base installed with resilient floor coverings.

#### **1.4 ACTION SUBMITTALS**

- A. Provide action submittals for all items in this specification section for review within a single submittal.
- B. Product Data: For each type of product.
- C. Samples: Units not less than 12" x12" of each color and pattern of floor tile required.
- D. Seam Samples: For seamless-installation technique indicated and for each flooring product, color, and pattern required; with seam running lengthwise and in center of 6-by-9-inch. Sample applied to a rigid backing and prepared by Installer for this Project.
- E. Product Schedule: For floor tile. Use same designations indicated on Drawings.
- F. Qualification Data for Installer: Signed by resilient sheet flooring manufacturer certifying the party listed complies with requirements specified in "Quality Assurance" article.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: provide manufacturer's requirement for maintenance of resilient sheet flooring with submission of project O&M manuals.
- B. Provide manufacturer's written warranty with submission of project O&M manuals.

#### **1.6 EXTRA MATERIALS SUBMITTALS**

- A. Furnish extra materials from the same lot as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Floor Tile: Furnish 2% (1 box for every 50 boxes or fraction thereof), of each type, color, and pattern of floor tile installed.

## 1.7 QUALITY ASSURANCE

- A. Manufacturer: Provide resilient flooring manufactured by a firm with a minimum of 10 years' experience with resilient flooring of types specified.
  - 1. Color Matching: Provide resilient flooring products from one manufacturer and the same batch lot or run to ensure color matching.
  - 2. Manufacturer capable of providing technical training and field service representation.
- B. Installer Qualifications: A qualified installer who employs workers for this Project who are trained and certified in techniques required by manufacturer for floor tile installation and seaming methods required, or INSTALL (International Standards and Training Alliance)-resilient-certified for the requirements of this project.

## 1.8 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics:
  - 1. Critical Radiant Flux Classification: ASTM E 648 or NFPA 253, Class I, not less than 0.45 W/sq. cm.
  - 2. Smoke Developed: ASTM E662 NBS smoke 450 or less.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in labeled packages. Store and handle in strict compliance with manufacturer's recommendations. Protect from damage due to weather, excessive temperatures, and construction operations.
  - 1. Store floor tile 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 floor tiles on flat surfaces.
- B. Deliver materials sufficiently in advance of installation to condition materials to the required temperature prior to installation.

## 1.10 PROJECT CONDITIONS

- A. Maintain temperature and humidity at service levels or 20° C (68° F), ± 3° C (5° F), and 50% RH ± 10% in areas to receive resilient flooring. Specified temperature shall be maintained at least 48 hours before, during, and 72 hours after installation.
- B. Close spaces to traffic during floor tile installation.
- C. Close spaces to traffic for 48 hours after floor tile installation.
- D. Install floor tile after other finishing operations in that area, including painting, have been completed.

### 1.11 WARRANTY

- A. Provide manufacturer's standard 1-year warranty against defects in manufacturing and workmanship for all flooring products.
- B. Provide manufacturer's standard warranty for each product for wear and defects.

## **PART 2 - PRODUCTS**

### 2.1 LUXURY VINYL TILE (LVT)

- A. Manufacturers/Products:
  - 1. See Architectural Finishes Schedule (No substitution)

### 2.2 INSTALLATION MATERIALS AND ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, portland cement based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
- C. Floor polish: Provide protective liquid floor sealer/polish products if/as recommended by manufacturer.
- D. Transition strips: Provide for all transitions to other materials.

## **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.
- B. 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 floor tile or may telegraph through the tile.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Remove existing finishes and associated adhesives and anchorages, and prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates: Prepare according to ASTM F 710.

1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
  2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents.
  3. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing.
  4. Moisture Testing: Proceed with installation only after substrates pass testing according to floor tile manufacturer's written recommendations, but not less stringent than the following:
    - a. Perform relative humidity test using in situ probes according to ASTM F 2170. Proceed with installation only after substrates have a maximum relative humidity level percentage required by the resilient floor manufacturer.
      - 1) Anhydrous calcium chloride test is not permitted as an alternate testing method to the situ probes.
- 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 floor tiles until they are the same temperature as the space where they are to be installed.
1. Move resilient products and installation materials into spaces where they will be installed at least 48 hours in advance of installation.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

### **3.3 FLOOR TILE INSTALLATION**

- A. Comply with manufacturer's written instructions for installing floor tile.
- B. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
1. Lay tiles square with room axis in pattern indicated (if provided).
- C. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
1. Lay tiles with grain running in one direction unless otherwise indicated.
- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.

- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door leaves.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in finished floor areas. Maintain overall continuity of color and pattern between pieces of tile installed on covers and adjoining tiles. Tightly adhere tile edges to substrates that abut covers and to cover perimeters.
- H. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- I. Install transition strips to transition smoothly to other adjacent materials.

### **3.4 CLEANING AND PROTECTION**

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
  - 1. Remove adhesive and other blemishes from exposed surfaces.
  - 2. Sweep and vacuum surfaces thoroughly.
  - 3. Damp-mop surfaces to remove marks and soil.
  - 4. Apply floor sealant or polish if/as recommended by manufacturer.
- C. Protect floor tile products from marks, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover floor tile until Substantial Completion.

**END OF SECTION 096519**

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## **SECTION 096813 - 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. This Section includes modular carpet tile.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include manufacturer's written data on physical characteristics, durability, and fade resistance. Include installation recommendations for each type of substrate.
- B. 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- (300-mm-) long Samples.

#### **1.4 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.
- B. Warranty: Special warranty specified in this Section.

#### **1.5 QUALITY ASSURANCE**

- A. Installer Qualifications: An experienced installer who is certified by the Floor Covering Installation Board or who can demonstrate compliance with its certification program requirements.
- B. Comply with applicable Carpet and Rug Institute (CRI) standards.

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

- A. Comply with CRI 104, Section 5, "Storage and Handling."

## 1.7 PROJECT CONDITIONS

- A. Comply with CRI 104, Section 7.2, "Site Conditions; Temperature and Humidity" and Section 7.12, "Ventilation."
- B. Environmental Limitations: Do not install carpet tiles until wet work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

## 1.8 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer's standard form in which manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
  - 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, more than 10 percent loss of face fiber, edge raveling, snags, runs, loss of tuft bind strength, dimensional stability, and delamination.
  - 3. Warranty Period: Lifetime.

## 1.9 EXTRA MATERIALS

- A. Furnish extra materials described below, before installation begins, that are from the same dye-lot to match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Carpet Tile: Full-size units equal to 5 percent of amount installed for each type indicated, but not less than 10 sq. yd. (8.3 sq. m).

## **PART 2 - PRODUCTS**

### 2.1 CARPET TILE

- A. Manufacturer and Products: (No Substitution)
  - 1. See Architectural Finishes Schedule.
- B. Size: See Architectural Finishes Schedule.



## 2.2    INSTALLATION ACCESSORIES

- A.    Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer.
- B.    Adhesives: Water-resistant, mildew-resistant, nonstaining, pressure-sensitive type to suit products and subfloor conditions indicated, that complies with flammability requirements for installed carpet tile and is recommended by carpet tile manufacturer for releasable installation.

## **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. Examine carpet tile for type, color, pattern, and potential defects.
- B.    Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2    PREPARATION

- A.    General: Comply with CRI 104, Section 6.2, "Site Conditions; Floor Preparation," and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile installation.
- 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 (3 mm) wide or wider and protrusions more than 1/32 inch (0.8 mm), unless more stringent requirements are required by manufacturer's written instructions.
- C.    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 carpet tile manufacturer.
- D.    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: Glue down; install every tile with full-spread, releasable, pressure-sensitive adhesive.
- 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 finish flooring as marked on subfloor. Use nonpermanent, nonstaining marking device.
- G. Install pattern parallel to walls and borders.

#### **3.4 CLEANING AND PROTECTION**

- A. Perform the following operations immediately after installing carpet tile:
  - 1. Remove excess adhesive, seam sealer, 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 104, Section 16, "Protection of 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.

**END OF SECTION 096813**

## **SECTION 099123 - 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. This Section includes surface preparation and the application of paint systems on the following interior substrates:
1. Steel.
  2. Gypsum board.
  3. Masonry
- B. Related Sections include the following:
1. Division 05 Sections for shop priming of metal substrates with primers specified in this Section.
  2. Division 08 Sections for factory priming windows and doors with primers specified in this Section.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Samples for Initial Selection: For each type of topcoat product indicated.
- C. Samples for Verification: For each type of paint system and in each color and gloss of topcoat indicated.
1. Submit Samples on rigid backing, 8 inches (200 mm) square.
  2. Step coats on Samples to show each coat required for system.
  3. Label each coat of each Sample.
  4. Label each Sample for location and application area.
- D. 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.
  2. Printout of current "MPI Approved Products List" for each product category specified in Part 2, with the proposed product highlighted.

#### **1.4 QUALITY ASSURANCE**

- A. MPI Standards:

1. Products: Complying with MPI standards indicated and listed in "MPI Approved Products List."
  2. Preparation and Workmanship: Comply with requirements in "MPI Architectural Painting Specification Manual" for products and paint systems indicated.
  3. VOC Content: Less than 100 grams per liter.
- B. Mockups: Apply benchmark samples of each paint system indicated and each color and finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.
    - a. Wall and Ceiling Surfaces: Provide samples of at least 100 sq. ft. (9 sq. m).
    - b. Other Items: Architect will designate items or areas required.
  2. Apply benchmark samples after permanent lighting and other environmental services have been activated.
  3. Final approval of color selections will be based on benchmark samples.
    - a. If preliminary color selections are not approved, apply additional benchmark samples of additional colors selected by Architect at no added cost to Owner.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. 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 (7 deg C).
1. Maintain containers in clean condition, free of foreign materials and residue.
  2. Remove rags and waste from storage areas daily.

#### 1.6 PROJECT CONDITIONS

- A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F (10 and 35 deg C).
- B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F (3 deg C) above the dew point; or to damp or wet surfaces.

#### 1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
1. Quantity: Furnish an additional 5 percent, but not less than 1 gal. (3.8 L) of each material and color applied.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Sherwin Williams (BASIS OF DESIGN)
  2. Glidden
  3. PPG Architectural Finishes, Inc.
  4. Behr Paint
  5. Benjamin Moore

### **2.2 PAINT, GENERAL**

- A. Material Compatibility:
1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
  2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.
- B. Colors: As selected from manufacturer's full palette.

### **2.3 PRIMERS/SEALERS**

- A. Interior Latex Primer/Sealer: MPI #50.

### **2.4 METAL and GALVANIZED PRIMERS**

- A. Epoxy, Anti Corrosive Primer: MPI #101

### **2.5 ACRYLIC PAINTS**

- A. Interior Acrylic (Semigloss): MPI #141 (Gloss Level 5).

### **2.6 LATEX PAINTS**

- A. Interior Latex (Eggshell): MPI #52 (Gloss Level 3).

### **2.7 POLYURETHANE**

- A. Pigmented Polyurethane, Two-Component: MPI #72.

### **2.8 MASONRY SEALERS/PRIMERS**

- A. Exterior primer/surfacer: 100% Acrylic, high-pH tolerant, breathable masonry primer
1. Sherwin Williams LX01W20U "Loxon Block Surfacer".

- B. Interior primer/water-block: Water blocking mildew-resistant masonry primer
  - 1. Sherwin Williams "Loxon Water Blocking Primer/Finish"

## 2.9 MASONRY FINISH COATINGS

- A. Exterior finish coating: 100% Acrylic, self-cleaning, breathable finish coating
  - 1. Sherwin Williams "Loxon Self-Cleaning Acrylic Coating"
- B. Interior finish coating: Water-based urethane
  - 1. Sherwin Williams B65W721/B65V720 "Acrylon WB"

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of work.
- B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
  - 1. Gypsum Board: 12 percent.
  - 2. Masonry: Per coating manufacturer
- C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.
- D. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
  - 1. Beginning coating application constitutes Contractor's acceptance of substrates and conditions.

### 3.2 PREPARATION

- A. Comply with manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.
- B. Remove plates, machined surfaces, and similar items already in place that 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.
  - 2. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.

- C. Clean substrates of substances that could impair bond or affect the sheen or uniformity of paint, including dirt, oil, grease, incompatible paints, encapsulants and residual adhesives.
- D. Remove incompatible primers and reprime substrate with compatible primers as required to produce paint systems indicated.
- E. Concrete Masonry Substrates:
  - 1. Remove loose paint, efflorescence and chalk deposits using a combination of the following as necessary:
    - a. Dry Ice blasting
    - b. Walnut media blasting
    - c. "Clean & Etch" by Sherwin Williams: Mix with water to 3.5% Phosphoric acid concentration, apply with a LOW pressure spray, scrub with stiff brush, and rinse with clear water with a LOW pressure spray, all in accordance with manufacturer's instructions.
  - 2. Use protective barriers and vacuums when blasting interior surfaces to capture dust and debris.
  - 3. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.
  - 4. Ensure that masonry weeps are not plugged by paint application. Inspect and clean as needed.
- F. Steel Substrates: Remove rust and loose mill scale. Clean using methods recommended in writing by paint manufacturer for the specific application.
- G. Gypsum Board Substrates:
  - 1. Surfaces previously finished with Vinyl Wall Finishes:
    - a. Remove existing Vinyl Wall Finishes where new paint finish is indicated using methods to minimize damage to substrate. Remove all adhesive residue using cleaners as recommended by manufacturer. Lightly sand surfaces to identify areas of remaining adhesives to remove. Treat paper facing of drywall with drywall conditioner (SW 828T8970 or equal). Skim coat wall surfaces to repair any damaged substrates and to provide a Level-5 untextured finish. Seal and prime surfaces to ensure a uniform sheen and appearance of subsequent paint finish.

### 3.3 APPLICATION

- A. Apply paints according to manufacturer's written instructions.
  - 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.
- B. If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
  - C. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.
  - D. Painting exterior architectural concrete masonry:
    1. Spray and backroll primer/block surfacer and topcoats per manufacturer
    2. Hand brush raked joints and reveals to ensure complete coverage and performance in joint surfaces
  - E. Painting Mechanical and Electrical Work: Paint new items exposed in equipment rooms and occupied spaces including, but not limited to, the following:
    1. Mechanical Work:
      - a. Uninsulated metal piping.
      - b. Uninsulated plastic piping.
      - c. Pipe hangers and supports.
      - d. Tanks that do not have factory-applied final finishes.
      - e. Visible portions of internal surfaces of metal ducts, without liner, behind air inlets and outlets.
      - f. Duct, equipment, and pipe insulation having cotton or canvas insulation covering or other paintable jacket material.
      - g. Mechanical equipment that is indicated to have a factory-primed finish for field painting.
    2. Electrical Work:
      - a. Electrical equipment that is indicated to have a factory-primed finish for field painting.

### 3.4 FIELD QUALITY CONTROL

- A. Testing of Paint Materials: Owner reserves the right to invoke the following procedure at any time and as often as Owner deems necessary during the period when paints are being applied:
  1. Perform tests for compliance with product manufacturer's requirements.
  2. Owner may direct Contractor to stop applying paints if test results show materials being used do not comply with product requirements. Contractor shall remove noncomplying-paint materials from Project site, pay for testing, and repaint surfaces painted with rejected materials. Contractor will be required to remove rejected materials from previously painted surfaces if, on repainting with complying materials, the two paints are incompatible.



### 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 PAINTING SCHEDULE

#### A. Exterior Masonry surfaces:

##### 1. Breathable, self-cleaning acrylic water-proofing finish system:

- a. Prime Coat: Exterior primer/surfacer: 100% Acrylic, high-pH tolerant, breathable masonry primer.
  - 1) Sherwin Williams LX01W20U "Loxon Block Surfacer", 8-10 mils DFT.
- b. Topcoat(s): 100% Acrylic, self-cleaning, breathable finish coating.
  - 1) Sherwin Williams "Loxon Self-Cleaning Acrylic Coating"

##### 2. Items/surfaces:

- 1) Exterior architectural and standard faced CMU indicated to be repainted.

#### B. Interior Masonry surfaces:

##### 1. Water-blocking interior acrylic finish system:

- a. Prime Coat: Interior primer/water-blocking mildew-resistant masonry primer
  - 1) Sherwin Williams "Loxon Water Blocking Primer/Finish".
- b. Topcoat(s): Water-based urethane
  - 1) Sherwin Williams B65W721/B65V720 "Acrylon WB"

##### 2. Items/surfaces:

- a. Interior standard faced CMU indicated to be repainted.
- C. Steel and Galvanized Substrates of new work or existing work indicated to be repainted:
- 1. Polyurethane, pigmented system: MPI EXT 5.3L:
    - a. Prime Coat: Epoxy, Anti Corrosive: MPI #101.
    - b. Second Coat: Pigmented Polyurethane, Two-Component: MPI #72.
  - 2. Items/surfaces:
    - a. Hollow metal steel doors and frames.
    - b. New mechanical piping
    - c. Exposed conduit on surfaces to be repainted
    - d. Exposed piping on surfaces to be repainted
    - e. New guard railings.
    - f. Sectional door frames
    - g. Other items as indicated.
- D. Gypsum Board Substrates of new work or existing work indicated to be repainted:
- 1. Latex System: MPI INT 9.2A.
    - a. Prime Coat: Interior latex primer/sealer, MPI #50.
    - b. Intermediate Coat: Interior latex matching topcoat, MPI#52.
    - c. Topcoat: Interior latex (eggshell), MPI #52 (Gloss Level 3).
  - 2. Items/surfaces:
    - a. All wall and soffit surfaces of Administration/office areas scheduled to receive new paint.
- E. Gypsum Board Substrates of new work or existing work indicated to be repainted: :
- 1. Acrylic System: MPI \_\_\_\_
    - a. Prime Coat: Interior latex primer/sealer, MPI #50.
    - b. Intermediate Coat: Interior Acrylic (Semigloss): MPI #141 (Gloss Level 5).
    - c. Topcoat: Interior Acrylic (Semigloss): MPI #141 (Gloss Level 5)
  - 2. Items/surfaces:
    - a. (None).

**END OF SECTION 099123**

## **SECTION 107313 - AWNINGS**

### **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. Fabric for fixed awnings.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Samples for Initial Selection: For fabric and color options
- C. Samples for Verification: For the following:
  - 1. Awning Fabric: 12-inch- (300-mm-) square section of fabric from dye lot to be used for the Work, with specified treatments applied. Mark face of fabric.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Sample Warranty: For special warranty.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For awnings to include in operation and maintenance manuals.
  - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. Methods for maintaining awning fabrics and finishes.
    - b. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.

#### **1.6 QUALITY ASSURANCE**

- A. Fabricator Qualifications: Shop that 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. Fabricator is a Master Fabric Craftsman certified by the Industrial Fabrics Association International.
  - 2. Fabricator's responsibilities include fabricating and installing awnings.

- B. Installer Qualifications: Minimum ten (10) years awning installation experience.

### 1.7 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit installation of awnings in exterior locations to be performed according to manufacturers' written instructions and warranty requirements.
- B. Field Measurements: Where awning installation is indicated to fit to other work, verify dimensions of other work by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for fenestration operation throughout the entire operating range. Notify Architect of discrepancies. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

### 1.8 WARRANTY

- A. Special Warranty: Manufacturer and fabricator agree to repair or replace components of awnings that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Deterioration of fabric including seam failure.
  - 2. Awning Warranty Period: Five years from date of Substantial Completion.
  - 3. Fabric Warranty Period: Five years from date of Substantial Completion.
  - 4. Thread Warranty Period: Five years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### 2.1 AWNING FABRICS

- 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. Basis of Design: Sunbrella® 100 percent acrylic fiber, color as selected by Architect, manufactured by Glen Raven Mills or other approved exterior grade fabric awning material that carries a minimum five (5) year manufacturer's warranty and is recommended by the manufacturer for the application.
    - a. Flame retardant to meet Building Code and Fire Marshal requirements.
- B. Fire-Test-Response Characteristics: Provide awning fabrics with the fire-test-response characteristics required, as determined by testing identical products according to test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
- C. Design: Match existing style, configuration and mounting method. Color: To be selected by A/E from available options.
- D. Fiber Type: 100% Acrylic.

## 2.2 AWNING FABRICATION

- A. Fabrics: Reinforce wear points and hardware attachment points with nonwoven mesh webbing.
- B. Attachments: Provide same or approved equivalent methods of attachment to the existing awning framework.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

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

### 3.2 INSTALLATION

- A. General: Install awning fabric on existing framework, securely connected to supports.
- B. Install awnings after other finishing operations, including joint sealing and painting of adjacent surfaces, have been completed.
- C. Attach fabric to frames as recommended by fabricator, to ensure tight, wrinkle-free fit of fabric to frame.
- D. Coordinate awning installation with flashing and joint-sealant installation so these materials are installed in sequence and in a manner that prevents exterior moisture from passing through completed exterior wall and roof assemblies.

### 3.3 CLEANING AND PROTECTION

- A. Cleaning: Immediately after erection, clean fabric of any dirt or debris using manufacture recommended methods that will not jeopardize fabric color, weather resistance or performance.

**END OF SECTION 107313**

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## **SECTION 108000 - MISCELLANEOUS SPECIALTIES**

### **PART 1 - GENERAL**

#### **1.1 GENERAL**

- A. Conditions of the Contract and Division 1 apply to this Section.
- B. Supply and install, complete in place, all miscellaneous specialties as indicated on the drawings and specified herein.

#### **1.2 DESCRIPTION**

- A. This section includes:
  - 1. Bollard covers
  - 2. Corner guards

#### **1.3 QUALITY ASSURANCE**

- A. Use only personnel thoroughly skilled and familiar with the manufacturer's recommended installation method.
- B. Comply with ADA mounting requirements.
- C. Comply with state, local, and ANSI handicapped accessibility requirements.

#### **1.4 SUBMITTALS**

- A. Refer to Section 013300 for Submittal Requirements.
- B. Product Data: Manufacturer's descriptive literature with technical data indicating materials, tests, and installation and storage instructions.

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

- A. Deliver materials to job site and adequately protect against damage while stored in dry location at site.
- B. Remove all damaged and unsuitable materials from the job site immediately.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- A. Bollard Post Sleeves/Covers
  - 1. Basis of design: J&P ATM Site Experts polyethylene with UV-inhibitors; domed top; ¼ inch thick; size to fit bollards. Color to be selected from manufacturer's entire palette of custom colors.

- a. Provide for all interior and exterior bollards. See plans for quantity and locations of bollards.
- B. Corner guards
  - 1. Basis-of-Design Product: Full height clear acrylic plastic corner guards equal to existing on walls being refinished.
    - a. Provide on all outside corners of studwalls in all areas receiving new wall finishes. See floor plans to determine quantity and locations.

### **PART 3 - EXECUTION**

#### **3.1 INSPECTION**

- A. Examine all subsurfaces to receive the work. Report in writing to General Contractor, with copy to Architect, any detrimental conditions. Failures to observe this injunction constitutes a waiver to any subsequent claims to the contrary and holds resilient Signage Contractor responsible for any corrections Owner may require. Commencement of the work will be construed as acceptance of all subsurfaces.
- B. Coordinate required surface corrections with Contractor responsible for installation.

#### **3.2 INSTALLATION**

- A. Install all items in strict accordance with manufacturer's written instructions and approved shop drawings.
- B. Units shall be installed rigid, straight, plumb, and level.
- C. Provide a secure, permanent installation, unless noted otherwise to be removable.
- D. Install per referenced accessibility requirements.

#### **3.3 ADJUST AND CLEAN**

- A. Clean all materials installed. Use cleaning agent recommended by manufacturer.
- B. Clean up premises of all litter, dirt, and debris created by work of this Section.

**END OF SECTION 108000**



## **SECTION 108113 – BIRD CONTROL BARRIER AND 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:
  - 1. Bird Barrier Spike Strips

#### **1.3 SYSTEM DESCRIPTION**

- A. Bird barrier spikes shall be a deterrent for birds trying to enter the hangar through gaps at the tops of the hangar door leaves.

#### **1.4 SUBMITTALS**

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

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

- A. Store materials in clean, dry area on pallets where they will not be damaged. Materials shall be stored in the original shipping package until needed for installation.

### **PART 2 - PRODUCTS**

#### **2.1 BIRD BARRIER STRIPS (BASIS-OF-DESIGN)**

- A. Manufacturer:
  - 1. Bird- B- Gone, Inc.  
15375 Barranca Pkwy, #D  
Irvine, California 92618  
(800) 392-6915
  - 2. Or Approved Equal
- B. Polycarbonate Bird Spike strips
  - 1. Construction/Material: Non-metallic one-piece rigid unbreakable polycarbonate spikes and mounting strips, U.V. stabilized, heat and weather resistant (+310F to -200F), minimum 2' lengths.
  - 2. Color: Clear
  - 3. Mounting: Stainless steel screws to bottom of metal panel soffit surfaces along door head.
  - 4. Warranty: Minimum 5 year

5. Size: As needed for effective coverage of gaps as recommended by manufacturer, but no less than 4" tall and 5" wide.
- C. Bird Barrier Strip Mounting Hardware: Use manufacturer's standard mounting hardware.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION AND PREPARATION**

- A. Examine actual conditions to verify correct product model, position and mounting provisions recommended by manufacturer for effective barrier.
- B. Examine the areas and conditions. Make sure all surfaces are clean, dry and free from debris or other conditions that could impede work.
- C. Remove existing bird spikes to allow installation of all new bird spikes.

### **3.2 INSTALLATION**

- A. Bird Barrier Strips:
  1. Install on bottom of metal panel soffit along head of all hangar door leaves and between tops of hangar door leaves to provide a continuous barrier to bird entry.
  2. Carefully position strips for effective barrier and to avoid interference with or damage from door operation.
  3. Cut and trim as necessary for job conditions.

### **3.3 CLEANING AND PROTECTION**

- A. At end of each workday, remove rubbish and other discarded materials from Project site.
- B. Protect work of other trades against damage from installation operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by the Architect, and leave in an undamaged condition.
- C. At completion of construction activities of other trades, touch up and restore damaged surfaces.

**END OF SECTION 108113**

## **SECTION 122413 – ROLLER WINDOW SHADES**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Sunscreen roller shades.

#### **1.2 RELATED SECTIONS**

- A. Section 011000 – Summary of the Work, and other sections in Division 1.

#### **1.3 REFERENCES**

- A. ASTM G 21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- B. NFPA 701 - Fire Tests for Flame-Resistant Textiles and Films.

#### **1.4 ACTION SUBMITTALS**

- A. Submit under provisions of Section 012500.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
  - 1. Preparation instructions and recommendations.
  - 2. Styles, material descriptions, dimensions of individual components, profiles, features, finishes and operating instructions.
  - 3. Storage and handling requirements and recommendations.
  - 4. Mounting details and installation methods.
- C. Shop Drawings: Plans, elevations, sections, product details, installation details, operational clearances and relationship to adjacent work.
- D. Window Treatment Schedule: For all roller shades. Use same room designations as indicated on the Drawings and include opening sizes and key to typical mounting details.
- E. Selection Samples: For each finish product specified, one set of shade cloth options and aluminum finish color samples representing manufacturer's full range of available colors and patterns.
- F. Verification Samples: For each finish product specified, one complete set of shade components, unassembled, demonstrating compliance with specified requirements. Shadecloth sample and aluminum finish sample as selected. Mark face of material to indicate interior faces.
- G. Maintenance Data: Methods for maintaining roller shades, precautions regarding cleaning materials and methods, instructions for operating hardware and controls.

## 1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Obtain roller shades through one source from a single manufacturer with a minimum of twenty years experience in manufacturing products comparable to those specified in this section.
- B. Installer Qualifications: Installer trained and certified by the manufacturer with a minimum of ten years experience in installing products comparable to those specified in this section.
- C. Fire-Test-Response Characteristics: Passes NFPA 701 small and large-scale vertical burn. Materials tested shall be identical to products proposed for use.
- D. Anti-Microbial Characteristics: 'No Growth' per ASTM G 21 results for fungi ATCC9642, ATCC 9644, ATCC9645.
- E. Mock-Up: Provide a mock-up (manual shades only) of one roller shade assembly for evaluation of mounting, appearance and accessories.
  - 1. Locate mock-up in window designated by Architect.
  - 2. Do not proceed with remaining work until, mock-up is accepted by Architect.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver shades in factory-labeled packages, marked with manufacturer and product name, fire-test-response characteristics, and location of installation using same room designations indicated on Drawings and in the Window Treatment Schedule.

## 1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Install roller shades after finish work including painting is complete and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

## 1.8 WARRANTY

- A. Roller Shade Hardware and Chain Warranty: Manufacturer's standard non-depreciating twenty-five year limited warranty.
- B. Standard Shadecloth: Manufacturer's standard twenty-five year warranty.
- C. Roller Shade Installation: One year from date of Substantial Completion, not including scaffolding, lifts or other means to reach inaccessible areas.

## **PART 2 - PRODUCTS**

### 2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Mecho, which is located at: 42-03 35th St.; Long Island City, NY 11101; Tel: 718-729-2020; Fax: 718-729-2941; Email: communications@mechoshade.com; <http://www.mechoshade.com>

- B. Substitutions: Not permitted.
- C. Voluntary Alternate products: Other products and manufacturers may be bid as a voluntary alternate products. Any pricing for voluntary alternate products shall be listed separately from the pricing for the specified product and shall not be part of the overall project bid prices. Any alternate pricing must include line-by-line compliance or non-compliance with the specifications. If the alternate product is acceptable to the Architect, the specified manufacturer will be given the opportunity to provide an equivalent proposal.

## 2.2 ROLLER SHADE TYPE AND SHADECLOTH

- A. Manually Operated Shades:
  - 1. Mounting: Surface mounted.
  - 2. Configuration: Single solar shade cloth.
  - 3. Shade cloth Roll: Regular, from back (exterior side) of roller
  - 4. Solar Shade cloths: PVC/polyester or TPO/polyolefin, light filtering woven fabric, stain and fade resistant. Owner will select from:
    - a. Woven pattern at 1 percent open.
    - b. Woven pattern at 5 percent open.
    - c. Woven pattern at 3 percent open.
  - 5. Color: Selected from manufacturer's standard colors.

## 2.3 SHADE BAND

- A. Shade Bands: Construction of shade band includes the fabric, the hem weight, hem-pocket, shade roller tube, and the attachment of the shade band to the roller tube. Sewn hems and open hem pockets are not acceptable.
- B. Hem Pockets and Hem Weights: Fabric hem pocket with RF-welded seams (including welded ends) and concealed hem weights. Hem weights shall be of appropriate size and weight for shade band. Hem weight shall be continuous inside a sealed hem pocket. Hem pocket construction and hem weights shall be similar, for all shades within one room.
- C. Shade Band and Shade Roller Attachment:
  - 1. Use extruded aluminum shade roller tube of a diameter and wall thickness required to support shade fabric without excessive deflection. Roller tubes less than 1.55 inch (39.37 mm) in diameter for manual shades, and less than 2.55 inches (64.77 mm) for motorize shades are not acceptable.
  - 2. Provide for positive mechanical engagement with drive / brake mechanism.
  - 3. Provide for positive mechanical attachment of shade band to roller tube; shade band shall be made removable / replaceable with a "snap-on" "snap-off" spline mounting, without having to remove shade roller from shade brackets.
  - 4. Mounting spline shall not require use of adhesives, adhesive tapes, staples, and/or rivets.
  - 5. Any method of attaching shade band to roller tube that requires the use of adhesive, adhesive tapes, staples, and/or rivets are not acceptable.

## 2.4 SHADE FABRICATION

- A. Fabricate units to completely fill existing openings from head to sill and jamb-to-jamb of overall window bands, to be mounted outside (immediately adjacent to interior face) of the aluminum window frames, as follows:
  - 1. Unless otherwise recommended by manufacturer and approved by Architect, provide individual shadebands for each individual glazed unit with terminations between adjacent end-to-end shades centered on mullions or other defined vertical separations between individually glazed openings.
- B. Fabricate shadecloth to hang flat without buckling or distortion. Fabricate with heat-sealed trimmed edges to hang straight without curling or raveling. Fabricate unguided shadecloth to roll true and straight without shifting sideways more than 1/8 inch (3 mm) in either direction per 8 feet (2438 mm) of shade height due to warp distortion or weave design. Fabricate hem as follows:
  - 1. Hembar: Concealed hembar.
- C. Provide battens in standard shades as required to assure proper tracking and uniform rolling of the shadebands. Contractor shall be responsible for assuring the width-to-height (W:H) ratios shall not exceed manufacturer's standards or, in absence of such standards, shall be responsible for establishing appropriate standards to assure proper tracking and rolling of the shadecloth within specified standards. Battens shall be roll-formed stainless steel or tempered steel, as required.
- D. For railroaded shadebands, provide seams in railroaded multi-width shadebands as required to meet size requirements and in accordance with seam alignment as acceptable to Architect. Seams shall be properly located. Furnish battens in place of plain seams when the width, height, or weight of the shade exceeds manufacturer's standards. In absence of such standards, assure proper use of seams or battens as required to, and assure the proper tracking of the railroaded multi-width shadebands.
- E. Provide battens for railroaded shades when width-to-height (W:H) ratios meet or exceed manufacturer's standards. In absence of manufacturer's standards, be responsible for proper use and placement of battens to assure proper tracking and roll of shadebands.

## 2.5 COMPONENTS

- A. Access and Material Requirements:
  - 1. Provide shade hardware allowing for the removal of shade roller tube from brackets without removing hardware from opening and without requiring end or center supports to be removed.
  - 2. Provide shade hardware that allows for removal and re-mounting of the shade bands without having to remove the shade tube, drive or operating support brackets.
  - 3. Use only Delrin engineered plastics by DuPont for all plastic components of shade hardware. Styrene based plastics, and /or polyester, or reinforced polyester will not be acceptable.

B. Manual Operated Chain Drive Hardware and Brackets:

1. Provide for universal, regular and offset drive capacity, allowing drive chain to fall at front, rear or non-offset for all shade drive end brackets. Universal offset shall be adjustable for future change.
2. Provide hardware capable for installation of a removable fascia, for both regular and/or reverse roll, which shall be installed without exposed fastening devices of any kind.
3. Provide shade hardware system that allows for removable regular and/or reverse roll fascias to be mounted continuously across two or more shade bands without requiring exposed fasteners of any kind.
4. Provide shade hardware system that allows for operation of multiple shade bands (multi-banded shades) by a single chain operator, subject to manufacturer's design criteria. Connectors shall be offset to assure alignment from the first to the last shade band. Coordinate final arrangement of multi-banded shade operation with Owner.
5. Provide positive mechanical engagement of drive mechanism to shade roller tube. Friction fit connectors for drive mechanism connection to shade roller tube are not acceptable
6. Provide shade hardware constructed of minimum 1/8 inch (3 mm) thick plated steel or heavier as required to support 150 percent of the full weight of each shade.
7. Drive Bracket / Brake Assembly:
  - a. Drive assembly shall be fully integrated with all accessories, including, but not limited to: fascia, center supports and connectors for multi-banded shades.
  - b. Drive sprocket and brake assembly shall rotate and be supported on a welded 3/8 inch (9.5 mm) steel pin.
  - c. The brake shall be an over-running clutch design which disengages to 90 percent during the raising and lowering of a shade. The brake shall withstand a pull force of 50 lbs. (22 kg) in the stopped position.
  - d. The braking mechanism shall be applied to an oil-impregnated hub on to which the brake system is mounted. The oil impregnated hub design includes an articulated brake assembly, which assures a smooth, non-jerky operation in raising and lowering the shades. The assembly shall be permanently lubricated. Products that require externally applied lubrication and or not permanently lubricated are not acceptable.
  - e. The entire assembly shall be fully mounted on the steel support bracket, and fully independent of the shade tube assembly, which may be removed and reinstalled without effecting the roller shade limit adjustments.
  - f. Drive Chain: No. 10 qualified stainless steel chain rated to 90 lbs (41 kg) minimum breaking strength. Nickel plate chain shall not be accepted.

**2.6 ACCESSORIES**

A. Fascia:

1. Continuous removable extruded aluminum fascia that attaches to shade mounting brackets without the use of adhesives, magnetic strips, or exposed fasteners.
2. Fascia shall be able to be installed across two or more shade bands in one piece.

3. Fascia shall fully conceal brackets, shade roller and fabric on the tube.
4. Provide bracket / fascia end caps where mounting conditions expose outside of roller shade brackets.
5. Notching of Fascia for manual chain shall not be acceptable.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. 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.

#### **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 roller shades level, plumb, square, and true according to manufacturer's written instructions, and located so shade band is not closer than 2 inches (51 mm) to interior face of glass. Allow proper clearances for window operation hardware.
- B. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.
- C. Clean roller shade surfaces after installation, according to manufacturer's written instructions.
- D. Touch up, repair or replace damaged roller shades that cannot be repaired, in a manner approved by Architect, prior to Substantial Completion.
- E. Engage Installer to train Owner's maintenance personnel to adjust, operate and maintain roller shade systems.

#### **3.4 PROTECTION**

- A. Protect installed products until completion of project.

**END OF SECTION 122413**



## **SECTION 219000 – FIRE-SUPPRESSION SYSTEMS**

### **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 the work under this Section.

#### **1.2 SUMMARY**

- A. See drawings and Section 011000-SUMMARY OF THE WORK for description of the fire-suppression related work.
- B. This Section includes the following fire-suppression systems inside the building:
  - 1. Clean agent systems (replacement and extension).
  - 2. Wet-pipe systems (modifications).
  - 3. Related interconnections and modifications to other systems

#### **1.3 DEFINITIONS**

- A. NFPA: National Fire Protection Association
- B. FPE: Professional Fire Protection Engineer
- C. Listed: Products evaluated and approved for use in the intended application by Underwriter's Laboratories or FM Global
- D. AHJ: Authority Having Jurisdiction
- E. IAW: In Accordance With
- F. ASCE: American Society of Civil Engineers
- G. Design Drawings: Drawings in accordance with "Working Plans" as described in NFPA 13.

#### **1.4 QUALIFICATIONS**

- A. The Contractor shall have on his staff, or under subcontract a qualified FPE whose responsibilities shall include:
  - 1. Fire protection equipment selection and layout.
  - 2. Fire protection calculations.
  - 3. Preparing or directly supervising the preparation of fire protection shop drawing submittals.
  - 4. Monitoring of fire protection construction quality.
  - 5. Preparing the testing plan and for final commissioning and testing of the system.
  - 6. Attending pre-testing and final acceptance testing.

- B. For the purposes of these specifications, the FPE shall have one of the following qualifications:
1. The FPE shall hold all licenses necessary to perform work of this type.
  2. The FPE shall be familiar with all applicable local, state, and federal laws and regulations.
  3. The FPE shall be regularly engaged in the design, installation, testing, and servicing of fire protection systems.

## 1.5 PERFORMANCE REQUIREMENTS

- A. Standard Piping System Component Working Pressure: Listed for at least 175 psig.
- B. Fire-suppression sprinkler system design:
1. A designated FPE shall be responsible for all design work.
  2. The design shall be approved by the authorities having jurisdiction.
  3. The design shall include calculations for weight, volume, and concentration of extinguishing agent required for each hazard area.
  4. Specific sprinkler design parameters shall be per drawings, NFPA 13, NFPA 415, and NFPA 2001.

NOTE: See drawings for exceptions.

5. The design shall be capable of withstanding the effects of earthquake motions IAW ASCE Standard 7.

## 1.6 SUBMITTALS – TO BE SUBMITTED PRIOR TO START OF CONSTRUCTION

Note: Construction shall not commence until the following submittals have been reviewed and approved by the Owner.

- A. Product data for the following:
1. Piping materials, including couplings, flexible connections, and sprinkler specialty fittings.
  2. Pipe hangers and supports, including seismic bracing if applicable.
  3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
  4. Alarm devices, including electrical devices.
  5. Clean agent system, including extinguishing agent, agent tanks, discharge nozzles, agent release control panel, manual release station, smoke detector, horn/strobe, warning bell, and other system accessories necessary for a complete installation.
- B. Design drawings for entire sprinkler system. Design documents shall be signed and sealed by the FPE responsible for all design work. Document shall be full-sized and legible. Design documents shall include the features indicated in NPFA 13 which include but are not limited to:
1. Piping layout.

2. Valve and sprinkler locations.
3. Installation details.
4. Seismic design analysis.
5. Extinguishing agent containers, piping, and discharge nozzles.
6. Controls and alarms.

C. Proof of sprinkler system plan approval by AHJ.

Note: Contractor shall submit plans to AHJ for review per AHJ requirements.

#### 1.7 SUBMITTALS – TO BE SUBMITTED WITHIN 30 DAYS OF SUBSTANTIAL COMPLETION OF CONSRUCTION

- A. Completed certificate “Contractor’s Material and Test Certificate for Aboveground Piping” contained in NFPA 13.
- B. Welding certificates, if field welding was performed.
- C. Operation and Maintenance Data for products listed under “Product Data”, above, where applicable.
- D. Record Drawings: Submit drawings showing system as installed. Drawings shall include, but not are not limited to, all items included in “Design Drawings” as listed above in section 1.6.B.

#### 1.8 QUALITY ASSURANCE

- A. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
- B. Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
  1. NFPA 13
  2. NFPA 415
  3. NFPA 2001
- C. Piping materials shall bear label, stamp, or other markings of specified testing agency.

#### 1.9 PROJECT CONDITIONS

- A. Interruption of Existing Sprinkler Service: Do not interrupt sprinkler service to any facility unless permitted under the following conditions and then only after arranging to provide temporary sprinkler service according to requirements indicated:
  1. Notify Owner no fewer than seven days in advance of proposed interruption of sprinkler service.
  2. Do not proceed with interruption of sprinkler service without Owner's written permission.

## 1.10 COORDINATION

- A. Field verify, evaluate and document existing systems as necessary to properly integrate the required modifications and secure approval of the AHJ.
- B. Coordinate layout and installation of sprinklers with other construction, including but not limited to light fixtures, HVAC equipment, and partition assemblies.

## **PART 2 - PRODUCTS**

### 2.1 PIPE

- A. Schedule 40 steel pipe IAW NFPA 13.

### 2.2 FITTINGS

- A. Ferrous fittings IAW NFPA 13.

### 2.3 VALVES AND DEVICES

- A. Listed ferrous or bronze.

### 2.4 CLEAN AGENT SYSTEM

- A. Fire Extinguishing System
  - 1. Basis of Design: Minimax MX 1230
    - a. Agent Tank: Steel, self-adhesive nameplate indicating agent weight and gross weight of the complete charged assembly, pressurized at 360 psi.
    - b. Discharge Hose: Rubber, with stainless steel fittings.
    - c. Nozzle: Brass.
    - d. Release: 24V electric
    - e. Assembly and components to be UL Listed/FM Approved
- B. Fire Protection Fluid
  - 1. Basis of Design: 3M Novec 1230
- C. Agent Release Control Panel
  - 1. Basis of Design: Minimax MX-2002
- D. Devices
  - 1. Manual Release Station
    - a. Basis of Design: GE model 276-REL
  - 2. Manual Abort Station

- a. Basis of Design: GE model REL-ABT
- 3. Manual Disable Switch
  - a. Basis of Design: Potter model RCDS-1
- 4. Photoelectric Smoke Detector
  - a. Basis of Design: System Sensor model 2W-B
- 5. Alarms and Horn/Strobe
  - a. Pre-discharge warning
    - 1) Basis of Design: System Sensor model P2W
  - b. Discharge warning
    - 1) Basis of Design: System Sensor model SCW
  - c. Warning bell
    - 1) Basis of Design: Wheelock model MB-G6-24-R

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine areas and conditions, for compliance with hazard-area leakage requirements and other conditions affecting work performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PIPING APPLICATIONS**

- A. Clean Agent System:
  - 1. Pipe: Schedule 40 steel.

#### **3.3 PIPING JOINT APPLICATIONS**

- A. General (unless other indicated): Use welded, flanged, threaded, rolled-groove or cut-groove joints.
- B. Use fittings listed for the operating pressure of the system.

#### **3.4 PIPING INSTALLATION**

- A. Provide seismic bracing.

### 3.5 CLEAN AGENT SYSTEM

- A. Install fire extinguishing system. Install IAW manufacturer's instructions. Anchor extinguishing agent tank to substrate.
- B. Install agent release control panel. Install IAW manufacturer's instructions.
- C. Install pre-discharge warning inside each protected space.
- D. Install discharge warning outside each protected space, adjacent to ingress.
- E. Install warning bell inside each protected space.
- F. Install manual release, manual abort, and manual disable switch inside each protected space.
- G. Install all components IAW manufacturer's instructions.

### 3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

### 3.7 LABELING, IDENTIFICATION, AND PAINTING

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13, NFPA 415, and NFPA 2001.
- B. Install tags with unique identifier numbers on the following components:
  - 1. Agent release control panel.
  - 2. Alarm devices, including electrical devices.
  - 3. Components not listed above but may potentially require servicing.
- C. Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean agent fire extinguishing system.
- D. Install signs at entry doors to advise persons outside the protected space the meaning of the horn(s), bell(s), and strobe light(s) outside the protected space.

### 3.8 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 3. Energize circuits to electrical equipment and devices.
  - 4. Flush, test, and inspect sprinkler systems according to NFPA 13 "Systems Acceptance" Chapter.

- 5. Coordinate with fire alarm tests. Operate as required.
- B. Report test results promptly and in writing to AHJ.

### 3.9 CLEANING AND PROTECTION

- A. Clean dirt and debris from system components.
- B. Protect system components from damage until Substantial Completion.

### 3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train owner's maintenance personnel to adjust, operate, and maintain clean agent system.
- B. The proposed training agenda shall include, but not be limited to, the following items:
  - 1. Overview of system equipment and devices
  - 2. Overview of system operation
  - 3. Detailed operation guidelines
  - 4. Detailed maintenance procedures
  - 5. Periodic testing procedures

**END OF SECTION 219000**

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## **SECTION 223400 - FUEL-FIRED, DOMESTIC-WATER HEATERS**

### **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. Commercial, gas-fired, high-efficiency, storage, domestic-water heaters.
  - 2. Domestic-water heater accessories.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

#### **1.4 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: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.
- C. ASME Compliance:
  - 1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
  - 2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.
- 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."

#### **1.5 COORDINATION**

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

## 1.6    WARRANTY

- A.    Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.
1.    Failures include, but are not limited to, the following:
    - a.    Structural failures including storage tank and supports.
    - b.    Faulty operation of controls.
    - c.    Deterioration of metals, metal finishes, and other materials beyond normal use.
  2.    Warranty Periods: From date of Substantial Completion.
    - a.    Commercial, Gas-Fired, Storage, Domestic-Water Heaters:
      - 1)    Storage Tank: Five (5) years.
      - 2)    Controls and Other Components: Three (3) years.
    - b.    Compression Tanks: Five (5) years.

## **PART 2 - PRODUCTS**

### 2.1    COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

- A.    Commercial, Gas-Fired, High-Efficiency, Storage, Domestic-Water Heaters:
1.    Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a.    Bock Water Heaters.
    - b.    Bradford White Corporation.
    - c.    Heat Transfer Products, Inc.
    - d.    Smith, A. O. Corporation.
  2.    Description: Manufacturer's proprietary design to provide at least 95 percent combustion efficiency at optimum operating conditions.
  3.    Storage-Tank Construction: ASME-code steel with 150-psig (1035-kPa) minimum working-pressure rating.
    - a.    Tappings: Factory fabricated of materials compatible with tank. Attach tappings to tank before testing.
      - 1)    NPS 2 (DN 50) and Smaller: Threaded ends according to ASME B1.20.1.
      - 2)    NPS 2-1/2 (DN 65) and Larger: Flanged ends according to ASME B16.5 for steel and stainless-steel flanges and according to ASME B16.24 for copper and copper-alloy flanges.

- b. 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.
4. Factory-Installed Storage-Tank Appurtenances:
- a. Anode Rod: Electronic anode system or replaceable magnesium anode.
  - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
  - c. Drain Valve: Corrosion-resistant metal complying with ASSE 1005.
  - d. Insulation: Comply with ASHRAE/IESNA 90.1. Surround entire storage tank except connections and controls.
  - e. Jacket: Steel with enameled finish.
  - f. Burner or Heat Exchanger: Comply with UL 795 or approved testing agency requirements for gas-fired, high-efficiency, domestic-water heaters and natural-gas fuel.
  - g. Temperature Control: Adjustable thermostat.
  - h. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
  - i. Combination Temperature-and-Pressure Relief Valves: ANSI Z21.22 / CSA 4.4-M. Include one or more relief valves with total relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select one relief valve with sensing element that extends into storage tank.

## 2.2 DOMESTIC-WATER HEATER ACCESSORIES

### A. Thermal Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AMTROL, Inc.
  - b. Smith, A. O. Corporation.
  - c. Watts.
2. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank. Equal to Amtrol Therm-X-Trol model ST-12.
3. Construction:
  - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
  - b. 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.
  - c. Air-Charging Valve: Factory installed.

B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

C. Heat-Trap Fittings: ASHRAE 90.2.

- D. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.
- E. Gas Pressure Regulators: ANSI Z21.18/CSA 6.3, appliance type. Include pressure rating as required to match gas supply.
- F. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.
- G. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- H. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.
- I. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

### **2.3 SOURCE QUALITY CONTROL**

- A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test domestic-water heaters and storage tanks to minimum of one and one-half times pressure rating before shipment.
- C. Domestic-water heaters will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

## **PART 3 - EXECUTION**

### **3.1 DOMESTIC-WATER HEATER INSTALLATION**

- A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Division 03.
  - 1. Exception: Omit concrete bases for commercial domestic-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 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 domestic-water heaters to substrate.
- B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping.
- C. Install gas-fired, domestic-water heaters according to NFPA 54.
1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
  2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
  3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
- D. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains.
- F. Install thermometer on outlet piping of domestic-water heaters.
- G. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.
- H. Fill domestic-water heaters with water.
- I. Charge domestic-water thermal expansion tanks with air.

### 3.2 CONNECTIONS

- A. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

### 3.3 IDENTIFICATION

- A. Identify system components.

### 3.4 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. Domestic-water heaters will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain domestic-water heaters.

**END OF SECTION 223400**

## **SECTION 224200 - COMMERCIAL PLUMBING FIXTURES**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and other sections of these specifications, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes plumbing fixtures and related components to be replaced as indicated.

#### **1.3 DEFINITIONS**

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

#### **1.4 SUBMITTALS**

- A. Product Data: Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports and indicate materials and finishes, dimensions, construction details, and flow-control rates for each type of fixture indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring if applicable.
- C. Maintenance Data: For plumbing fixtures to include in maintenance manuals specified in Division 1.

#### **1.5 QUALITY ASSURANCE**

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
  - 1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.
- 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. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities, Public Law 90-480, "Architectural Barriers Act"; and

Public Law 101-336, "Americans with Disabilities Act" about plumbing fixtures for people with disabilities.

- D. Regulatory Requirements: Comply with requirements in U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about plumbing fixtures for people with disabilities.
- E. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- H. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
  - 1. Stainless Steel Fixtures Other Than Service Sinks: ASME A112.19.3M.
  - 2. Water Closet, Flushometer Trim: ASSE 1037.
- I. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:
  - 1. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
  - 2. Faucet Hose: ASTM D 3901.
  - 3. Faucets: ASME A112.18.1M.
  - 4. Hose-Connection Vacuum Breakers: ASSE 1011.
  - 5. Hose-Coupling Threads: ASME B1.20.7.
  - 6. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
  - 7. NSF Materials: NSF 61.
  - 8. Pipe Threads: ASME B1.20.1.
  - 9. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
  - 10. Supply and Drain Fittings: ASME A112.18.1M.
- J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
  - 1. Atmospheric Vacuum Breakers: ASSE 1001.
  - 2. Brass and Copper Supplies: ASME A112.18.1M.
  - 3. Manual Operation Flushometers: ASSE 1037.
  - 4. Plastic Tubular Fittings and Piping: ASTM F 409.
  - 5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
  - 6. Tubular Brass Drainage Fittings and Piping: ASME A112.18.1M.
- K. Comply with the following applicable standards and other requirements specified for miscellaneous components:
  - 1. Hose Coupling Threads: ASME B1.20.7.



2. Pipe Threads: ASME B1.20.1.

## 1.6 COORDINATION

- A. Coordinate existing rough-ins and existing plumbing fixture locations and models, and verify that fixtures can be installed to comply with original design and referenced standards.
- B. Before ordering or installing replacement fixture:
  1. Flushometers: Contractor shall verify that flow rates of new flush valves are compatible with the existing fixtures they serve.
  2. All fixtures: Contractor shall field verify existing conditions, supply piping arrangements, fixture hole spacings and other conditions to confirm and adjust model numbers as needed to ensure proper fit-up.

## **PART 2 - PRODUCTS**

### 2.1 MANUFACTURERS

- A. For fixture descriptions in other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection subject to compliance with requirements; provide products by the manufacturers specified.
  1. Where there is a model number shown, the design is based on that manufacturer and model.

### 2.2 LAVATORY FAUCETS

- A. Lavatory Faucet: Include hot and cold water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.
  1. Manufacturers:
    - a. Chicago (See Drawings.)
    - b. Sloan
    - c. Zurn
    - d. American Standard
    - e. Kohler
    - f. Speakman
  2. Maximum Flow Rate: 1.0 gpm (3.8 L/min.) at 40 psi, unless otherwise indicated.
  3. Body Material: Die cast metal.
  4. Finish: Polished chrome plate.
  5. Mounting: Deck, exposed. Verify hole spacing before ordering.
  6. Inlet: Match existing supply piping.
  7. Spout: Rigid.
  8. Spout Outlet: Aerator.
  9. Operation: Manual
  10. Drain: Grid.

### 2.3 SINK FAUCETS

- A. Service Sink Faucet: Include hot and cold water indicators; coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.
1. Manufacturers:
    - a. Chicago (See Drawings)
    - b. Zurn
    - c. American Standard
    - d. Kohler
    - e. Speakman
  2. Maximum Flow Rate: 2.0 gpm (7.6 L/min.), unless otherwise indicated.
  3. Body Material: Cast brass.
  4. Finish: Rough brass.
  5. Type: Service sink faucet with stops in shanks, vacuum breaker, hose-thread outlet, and pail hook.
  6. Backflow Protection Device for Hose Outlet: Required.
  7. Centers: VERIFY EXISTING BEFORE ORDERING
  8. Mounting: Back/wall, exposed.
  9. Handles: Wrist blade, 4" (100 mm).
  10. Inlets: NPS 3/8 (DN 10) plain-end tubing.
  11. Spout: Rigid, cast with wall brace.
  12. Spout Outlet: Hose thread.
  13. Vacuum Breaker: Required.
  14. Drain: Not required.
  15. Tempering Device: Not required.

### 2.4 FLUSHOMETERS

- A. Flushometer for Water Closets: Cast-brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, and copper or brass tubing, and polished chrome-plated finish on exposed parts. Provide a manual override.
1. Manufacturers:
    - a. Sloan (See Drawings)
    - b. Zurn
    - c. Coyne & Delany
    - d. Josam
  2. Internal Design: Diaphragm or piston operation.
  3. Style: Exposed.
  4. Inlet Size: NPS 1 (DN 25). Verify existing.
  5. Operation: Manual
  6. Consumption: 1.6 gal/flush (6.0 L/flush) at 15 psi for Water Closets. (VERIFY compatible with proper operation of existing water closets before ordering)

- B. Flushometer for Urinal: Cast-brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, and copper or brass tubing, and polished chrome-plated finish on exposed parts. Provide a manual override.
1. Manufacturers:
    - a. Sloan (See Drawings)
    - b. Zurn
    - c. Coyne & Delany
    - d. Josam
  2. Internal Design: Diaphragm or piston operation.
  3. Style: Exposed.
  4. Inlet Size: NPS  $\frac{3}{4}$  (DN 20).
  5. Operation: Manual
  6. Consumption: 1.0 gal./flush (3.75 L/flush) at 15 psi for Urinal (VERIFY compatible with proper operation of existing urinals before ordering)

## 2.5 KITCHEN SINKS

- A. Kitchen Sinks, KS-1, Residential, counter-mounting, stainless-steel fixture.
1. Products:
    - a. Dayton Products, Inc.
    - b. Elkay Manufacturing Co.
    - c. Just Manufacturing Co.
  2. Overall Size: Match existing.
  3. Number of Compartments: One.
  4. Sink Faucet: Reuse existing, Deck Mounted. Verify hole spacing required for existing faucet.
  5. Supplies: NPS 1/2 (DN 15) chrome-plated copper with stops.
  6. Drain Piping: NPS 1 $\frac{1}{2}$  (DN 40) chrome-plated cast-brass trap, 0.045" (1.1 mm) thick tubular brass waste to wall, and wall escutcheons.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine existing conditions and roughing-in for water, soil and for waste piping systems and supports to verify actual locations and sizes of piping connections and that locations and types of supports match those indicated, before plumbing fixture installation.
- B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2    FIXTURE INSTALLATION

- A. Assemble fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install counter-mounting fixtures in and attached to casework.
- C. Install fixtures level and plumb according to manufacturers' written instructions and roughing-in drawings.
- D. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
- E. Exception: Use ball valves if stops are not specified with fixture.
- F. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- G. Install Flushometer valves for accessible water closets. Install other actuators in locations that are easy for people with disabilities to reach.
- H. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- I. Install water-supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.
- J. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.
- K. Install traps on fixture outlets.
  - 1. Exception: Omit trap on fixtures with integral traps.
- L. Re-install existing disposer in outlet of sinks indicated to reuse disposer.
- M. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings.
- N. Seal joints between fixtures and walls, floors, and counters using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

### 3.3    CONNECTIONS

- A. Provide new fittings to fit up new components with existing plumbing and modify existing plumbing if needed to install new fixtures.
- B. Connect water supplies from water distribution piping to fixtures.
- C. Connect drain piping from fixtures to drainage piping.

- D. Supply and Waste Connections to Plumbing Fixtures: Connect fixtures with water supplies, stops, risers, traps, and waste piping. Use size fittings required to match fixtures. Connect to plumbing piping.
- E. Supply and Waste Connections to Fixtures and Equipment Specified in Other Sections: Connect fixtures and equipment with water supplies, stops, risers, traps, and waste piping specified. Use size fittings required to match fixtures and equipment. Connect to plumbing piping.

### 3.4 FIELD QUALITY CONTROL

- A. Verify that new fixtures are types specified for locations where installed.
- B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.
- C. Inspect installed fixtures for damage. Replace damaged fixtures and components.
- D. Test installed fixtures after water systems are re-pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

### 3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust disposers.
- C. Adjust water pressure at faucets, shower valves, and Flushometer valves to produce proper flow and stream.
- D. Replace washers and seals of leaking and dripping faucets and stops.

### 3.6 CLEANING

- A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
  - 1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
  - 2. Remove sediment and debris from drains.

**END OF SECTION 224200**

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## **SECTION 224700 - DRINKING FOUNTAINS AND WATER COOLERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

- A. Drawings and General Provisions of the Contract, including General and Supplementary Conditions and other sections of these specifications, apply to this Section.

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Pressure water coolers (to replace existing).
  - 2. Fixture supports (if necessary to replace existing EWC).

#### **1.3 DEFINITIONS**

- A. Accessible Water Cooler: Fixture that can be approached and used by people with disabilities.
- B. Fitting: Device that controls flow of water into or out of fixture.
- C. Fixture: Drinking fountain or water cooler, unless one is specifically indicated.
- D. Water Cooler: Electrically powered fixture for generating and delivering cooled drinking water.

#### **1.4 SUBMITTALS**

- A. Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each type of fixture indicated.
- B. Shop Drawings: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
- D. Maintenance Data: For fixtures to include in maintenance manuals specified in other sections of these specifications.

#### **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. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and

Public Law 101-336, "Americans with Disabilities Act"; about fixtures for people with disabilities.

- C. Regulatory Requirements: Comply with requirements in the U.S. Architectural & Transportation Barriers Compliance Board's "Uniform Federal Accessibility Standards (UFAS), 1985-494-187" about fixtures for people with disabilities.
- D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

## 1.6 COORDINATION

- A. Coordinate roughing-in and final fixture locations, and verify that fixtures can be installed to comply with original design and referenced standards.

## **PART 2 - PRODUCTS**

### 2.1 MANUFACTURERS

- A. For fixture descriptions in other Part 2 articles where the subparagraph titles Products, and Manufacturers introduce a list of manufacturers and their products or manufacturers only, the following requirements apply for product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified in other Part 2 articles.

### 2.2 PRESSURE WATER COOLERS

- A. Water Coolers, ARI 1010, Type PB, pressure with bubbler.
  - 1. Acceptable Manufacturers: (Basis of design model number)
    - a. Elkay Manufacturing Co. (Model No.: EZSG8WSLK)
    - b. Halsey Taylor;
    - c. Haws Corporation.
    - d. Oasis Corp.
    - e. Sunroc Corp.
  - 2. Cabinet: Enameled steel with stainless-steel top.
  - 3. Bubbler: One, with automatic stream regulator, located on deck.
    - a. Control: Front and side electronic push bars.
  - 4. Bottle filler: One, on back wall.
    - a. Control: Electronic sensor



5. Supply: NPS 3/8 (DN 10) with ball, valve and filter. Use dielectric coupling to isolate from supply piping.
6. Drain: Grid with NPS1<sup>1</sup>/<sub>4</sub> (DN 32) minimum horizontal waste and trap complying with ASME A112.18.2M. Use plastic drain trap to isolate from building plumbing.
7. Cooling System: Electric with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
  - a. Capacity: 8.0 gph (0.0053 L/s) of 50°F (10°C) cooled water from 80°F (27°C) inlet water and 90°F (32°C) ambient air temperature.
  - b. Electrical Characteristics: 120V ac; single phase; 60 Hz.

### 2.3 FIXTURE SUPPORTS (if needed to replace existing)

- A. Off-Floor, Plumbing Fixture Supports: ASME A112.6.1M, water-cooler carriers. Include vertical, steel uprights with feet and tie rods and bearing plates with mounting studs matching fixture to be supported.
  1. Acceptable Manufacturers:
    - a. Josam Co.
    - b. Smith, Jay R. Mfg. Co.
    - c. Tyler Pipe; Wade Div.
    - d. Watts Industries, Inc.
    - e. Zurn
  2. Type I: Hanger-type carrier with two vertical uprights.
  3. Type II: Bi-level, hanger type carrier with three vertical uprights.
  4. Supports for Accessible Fixtures: Include rectangular, vertical, steel uprights instead of steel pipe uprights.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Examine existing roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.
- B. Examine walls and floors for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 APPLICATIONS

- A. Use carrier off-floor supports for wall-hanging fixtures, unless otherwise indicated.
- B. Use mounting frames for recessed water coolers, unless otherwise indicated.
- C. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view. Plain copper tube, fittings, and valves may be used in concealed locations.

### 3.3 INSTALLATION

- A. Install off-floor supports affixed to building substrate and attach wall-hanging fixtures, unless otherwise indicated.
- B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.
- C. Install fixtures level and plumb.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate or globe valve. Install valves in locations where they can be easily reached for operation.
- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Refer to other sections of these specifications for escutcheons.
- G. Seal joints between fixtures and walls and floors using sanitary type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color.

### 3.4 CONNECTIONS

- A. Piping installation requirements are specified in other sections of these specifications. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect water supplies from water distribution piping to fixtures.
- C. Connect drain piping from fixtures to drainage piping.
- D. Ground equipment: 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 FIELD QUALITY CONTROL

- A. Water-Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
- B. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.
- C. Report test results in writing.

### 3.6 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust water-cooler temperature settings.

### 3.7    CLEANING

- A.    After completing fixture installation, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
  
- B.    Clean fixtures, on completion of installation, according to manufacturer's written instructions.

**END OF SECTION 224700**

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## **SECTION 230500 - 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.

#### **1.2 ACCURACY OF DATA AND CONTRACT DRAWINGS**

- A. The design drawings are diagrammatic and they may not show all physical arrangements, offsets, bends, or elbows which may be required for installation of various materials, equipment, piping, and ductwork systems in allotted spaces. The Contractor shall examine these and other available drawings to determine space limitations and interferences. The Contractor shall be responsible for making any minor changes in location of equipment, pipe and ductwork from that shown on drawings and for all physical details required for installation. Cost for adapting Contractor's work to jobsite conditions shall not be considered as basis of an extra cost to contract. The Contractor shall get approval before proceeding with any change.
- B. Elevation of piping, ductwork and equipment indicated on drawings are to be used as guidelines to assist Contractor with installations. Minor changes to these elevations may be necessary to eliminate unforeseen interferences. The Contractor shall get approval before proceeding with any changes in elevations.
- C. Information pertaining to new and existing conditions that are described in the specifications or appear on drawings are based on available records. While such data has been collected with reasonable care, there is no expressed or implied guarantee that conditions so indicated are entirely representative of those actually existing or that unlooked for developments may not occur. Such information is merely provided to assist the Contractor in his investigation of conditions.
- D. The Contractor must carefully examine the drawings, specifications and project site, and verify all measurements, distances, levels, materials, equipment, etc. before starting work.
- E. Drawings shall not be scaled for determining exact dimensions or location of equipment.
- F. Check, verify, and coordinate work with drawings and specifications prepared for other trades. Include modifications, relocations, or adjustments necessary to complete work or to avoid interference with other trades.
- G. Contractor may install additional piping, fittings, and valves, not shown on drawings, for testing purposes or for convenience of installation or start-up. Where such materials are installed, they shall comply with specifications and shall be sized to be compatible with system design. Remove such installed materials when they interfere with design conditions or as directed by Architect.

- H. Except as otherwise specified herein or indicated on drawings, furnish and install all piping, tubing, valves, specialties and supports to connect fixtures and equipment into their respective systems as required for or incidental to the proper operation of the indicated systems. This shall include the following systems:
1. All miscellaneous piping called for on piping and instrument diagrams, regardless of whether or not indicated in the specifications or on the drawings. Reference shall be made to piping and instrument diagrams, control air piping drawings, and manufacturer's equipment drawings to determine full extent or required piping.

### 1.3 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. HVAC demolition.
  9. Equipment installation requirements common to equipment sections.
  10. Painting and finishing.
  11. Concrete bases.
  12. Supports and anchorages.

### 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. Except as otherwise defined in greater detail, terms "provide", "furnish", and "install" as used in these Contract Documents shall have the following meanings:
1. "Provide" or "provided" shall mean "furnish and install."
  2. "Furnish" or "furnished" does not include installation.

3. "Install" or "installed" does not include furnishing.
- G. The following are industry abbreviations for plastic materials:
1. CPVC: Chlorinated polyvinyl chloride plastic.
  2. PE: Polyethylene plastic.
  3. PVC: Polyvinyl chloride plastic.

- H. 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: None.

### 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. 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. The Contractor or the Contractor's authorized representative must be present to accept delivery of all equipment and materials furnished by him. The Owner's personnel will not knowingly accept, unload or store anything delivered to the site for the Contractor's use. Inadvertent acceptance of delivered items by a representative of the Owner shall not constitute acceptance or responsibility for any of the materials or equipment. It shall be the Contractor's responsibility to assume all liability for any equipment or materials furnished by him which are delivered to the job site.

- D. Storage of materials on the grounds and within the building shall be in strict accordance with instructions of the Owner. Storage of materials within building shall at no time exceed design carrying capacity of the structural system.
- E. The Owner assumes no responsibility for materials stored in building or on the site. Each Contractor shall assume full responsibility for all losses or damage due to the storing of his materials.
- F. Handle items carefully to avoid damage to components, enclosures and finishes. Follow the manufacturer's rigging instructions when handling and moving equipment.

#### 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.

#### 1.9 CODES AND REGULATIONS

- A. All codes and regulations of Federal, State, and Local Authorities and utility companies shall become part of this specification and must be adhered to where they exceed requirements as shown on the drawings or stated in the specifications, without additional cost to the Contract.

#### 1.10 CONTINUITY OF EXISTING SERVICES

- A. Do not interrupt or change existing services without prior written approval. When interruption is required, coordinate length of service time with Owner to minimize disruption of occupant activities.

#### 1.11 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. The Contractor shall provide operating and maintenance instruction manuals covering each and every item of equipment and devices furnished or erected by the Contractor prior to "Substantial Completion" as required by Division 1.
- B. Each separate manual shall consist of the following:
  - 1. Neatly typewritten table of contents including contractor's name, address and telephone number; list of each product referenced in manual; and name, address and telephone number of installing contractor and maintenance contractor for each product.
  - 2. Tabbed sections of catalog data and literature for each product including model number, description and component parts; operating procedures; maintenance procedures; servicing and lubrication schedules; description of sequence of operations; parts lists; illustrations, assembly drawings and diagrams required for



- maintenance; any additional drawings, diagrams, charts or written text which may be required to supplement product data for particular installation; certified test and balance report; list of control point labels, and wiring diagrams.
3. Copy of warranty, bond and/or service contract issued for each product including an information sheet for operations personnel with proper procedures in event of a product failure and instances which might affect validity of warranties or bonds.
  4. Full size sheets, if required, shall be folded into special holding pockets. Faxed, handwritten, or illegible materials are not acceptable.
- C. Prior to final inspection or acceptance, fully instruct designated facility operating and maintenance personnel on operation, adjustment and maintenance of products, equipment and systems. Review contents of operating and maintenance manual with personnel in full detail to explain all aspects of operations and maintenance.

#### 1.12 POSTED OPERATIONS INSTRUCTIONS (POIs)

- A. Provide comprehensive posted operations instructions for all equipment and systems. Instructions shall be developed as CADD schematics, files, or plans and include printed text. Information shall include but not be limited to air system schematics, water system schematics, equipment schedules, valve charts, controls points list, sequence of operations, and building plan showing equipment locations. They shall be framed under glass with extruded metal frame and shall be bolted to the mechanical room wall. Instructions shall be in color and use color graphics for illustrative purposes.
- B. As an alternative to posting in mechanical rooms, POIs may be incorporated into the graphics package of the base central Energy Management and Control System (EMCS).

#### 1.13 PROTECTION OF ROOF

- A. Contractors are cautioned that they must exercise extreme care in any activity involving contact with any installed roof membrane.
- B. Construct protective plywood (3/4 in. thick) runways across the roof for moving, setting, and installing equipment and piping systems. No activity on the roof will be permitted without this protection. Start runways at the point of origin of any equipment placed on roof and terminate at the point of installation on curb or base. At completion of work, or when directed by the [Government] [Owner], completely remove, neatly and cleanly, without damage to roofing system, these protective items and runways.
- C. Any and all repairs necessary to bring the roofing system to its original condition shall be made by an approved Roofing Contractor and paid for by the Contractor responsible for the damage.

#### 1.14 WORK COORDINATION

- A. All Trades shall work in cooperation with each other, and fit their work into the structure as job conditions may demand. All final decisions as to right-of-way and run of pipes and ducts, etc. shall be made by the Owner. In general, priority shall be arranged as follows: (in order of preference)
1. Recessed lighting fixtures

2. Piping which must be drainable
3. Sheet metal ductwork
4. Lighting fixtures
5. Plumbing waste lines, downspouts, vents and sprinkler piping
6. Gravity water lines
7. Heating hot and chilled water lines
8. Refrigerant lines
9. Plumbing water and gas and air lines
10. Electrical conduit
11. Control wiring conduit

#### 1.15 INSPECTION

- A. The Contractor shall verify the location of underground service, utilities, structures, etc., which may be encountered or be affected by his work and shall be responsible for any damage caused by neglect to provide proper precautions or protection.
- B. Any work that is to be concealed, such as inside walls, above ceilings, soffits, shall be inspected by Owner prior to concealment.

### **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, but are not limited to, 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. 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, 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.
- F. 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 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. Available Manufacturers:
    - 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. Available Manufacturers:
    - 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. Available Manufacturers:
    - 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. Available Manufacturers:
    - 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. Available Manufacturers:
    - 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. Available Manufacturers:
    - a. Advance Products & Systems, Inc.
    - b. Calpico, Inc.
    - c. Central Plastics Company.
    - d. Pipeline Seal and Insulator, Inc.
  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. Available Manufacturers:
    - 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. Available Manufacturers:
  - 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. Available 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.

## 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. 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.

## 2.8 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, Stamped-Steel Type: With spring clips and chrome-plated finish.
- D. Split-Plate, Stamped-Steel Type: With concealed hinge, spring clips, and chrome-plated finish.
- E. One-Piece, Floor-Plate Type: Cast-iron floor plate.

F. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

## 2.9 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.

## 2.10 SEALANTS

A. Reference Division 7 specification for sealant requirements.

# **PART 3 - EXECUTION**

## 3.1 GENERAL

A. Verify elevations and measurements prior to installation of materials.

## 3.2 HVAC DEMOLITION

A. Refer to Division 01 for cutting and patching.

B. Disconnect, demolish, and remove HVAC 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. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
7. 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.

D. Removed materials must not be reused unless otherwise specified or directed to be so.

- E. Arrange and pay for disconnecting, removing and capping utility services within areas of demolition. Place markers to indicate location of disconnected services. Identify service lines and capping locations on Project Record Documents.
- F. Refrigerant shall be recovered from any refrigeration unit that will be removed or salvaged. Recovered refrigerants must be bottled in pressure containers suitable for shipping per DOT requirement and remain property of the Government. Salvage or disposal by Contractor is not permitted
- G. For any existing equipment being relocated and re-installed, the contractor shall test functionality of existing unit and report in writing any functional deficiencies. Failure to submit this report shall imply that the unit is fully functional and will obligate the contractor to repair any discovered deficiencies prior to project closeout. If functionality test report identifies unit deficiencies, the contractor shall notify the Owner and Architect/Engineer immediately.

### 3.3 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.
- 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. Full lengths of pipe shall be used. Short lengths and couplings will not be permitted.
- L. Where more than one pipe material specification or valve is allowed for particular service, the Contractor is required to use one and only one of the pipe materials

specified throughout project. Two or more different piping materials or valves for same service will not be allowed unless indicated otherwise on drawings or specified herein.

- M. Independently support piping so that its weight shall not be supported by the equipment to which it is connected.
- N. Size reduction shall be made using reducing fittings; bushings are not acceptable.
- O. Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.
- P. "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.
- Q. Cover ends of piping during installation to keep inside of piping clean.
- R. Piping shall not be routed through electrical rooms or transformer vaults, or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment.
- S. Use only wrenches having square flat jaws, or non-metallic strap wrenches on brass specialties; wrench marks not permitted.
- T. Select system components with pressure rating equal to or greater than system operating pressure.
- U. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
  - 1. New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Insulated Piping: One-piece, stamped-steel type with spring clips.
    - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
    - d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type or split-plate, stamped-steel type with concealed hinge and set screw.
    - e. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with concealed hinge and spring clips.
    - f. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with spring clips.
    - g. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
  - 2. Existing Piping: Use the following:
    - a. Insulated Piping: Split-plate, stamped-steel type with concealed hinge and spring clips.



- b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and spring clips.
  - c. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-plate, stamped-steel type with concealed hinge and set screw.
  - d. Bare Piping in Unfinished Service Spaces: Split-plate, stamped-steel type with concealed hinge and set screw or spring clips.
  - e. Bare Piping in Equipment Rooms: Split-plate, stamped-steel type with set screw or spring clips.
  - f. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting, floor-plate type.
- V. Sleeves are not required for core-drilled holes thru solid concrete walls.
- W. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.
- X. 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 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 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.
- Y. 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.
- Z. 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.
- AA. Verify final equipment locations for roughing-in.
- BB. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

### 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 "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. 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.

### 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 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 HVAC 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.

### 3.7 PAINTING

- A. Painting of HVAC 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.

### 3.8 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 HVAC materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

### 3.9 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 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.

### 3.10 GROUTING

- A. Mix and install grout for HVAC 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 230500**

## **SECTION 230513 - 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 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.

#### **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 INDUCTION 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.
- 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.

#### 2.4 POLYPHASE INDUCTION 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. Shaft Grounding: Provide bearing protection grounding rings to bleed current from the motor shaft to the motor casing.

#### 2.5 SINGLE-PHASE INDUCTION 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: 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.

## **2.6 ELECTRONICALLY COMMUTATED MOTOR (ECM)**

- A. Description: Electrically commutated, adjustable speed, brushless direct current (BLDC) motor.
- B. Constant CFM, constant torque
- C. Multi-Speed: Shall be speed controllable down to 20% of full speed using a 0-10 VDC signal.
- D. Efficiency: Energy efficient, as defined in NEMA MG 1.
- E. Service Factor: 1.00

### **PART 3 - EXECUTION (Not Used)**

**END OF SECTION 230513**

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## **SECTION 230519 - 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 ACTION SUBMITTALS**

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

#### **1.3 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 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: Cast aluminum; 9-inch nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: plastic.
8. Stem: Aluminum 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, 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: CNR or 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, ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1 inch, 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
  - 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. Terice, 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: Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, 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.
8. Pointer: Dark-colored metal.
9. Window: plastic.
10. Ring: Stainless steel.
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 or NPS 1/2, 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 stainless-steel pipe with NPS 1/4 or NPS 1/2 pipe threads.
- C. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

## 2.5 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. 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 or NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

## 2.6 TEST-PLUG KITS

- 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. 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 one test-plug kit(s) containing one 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. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
- D. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- E. Carrying Case: Metal or plastic, with formed instrument padding.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. Install thermowells with socket extending to center of pipe 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 direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids (except steam).
- H. Install test plugs in piping tees.

I. Install thermometers in the following locations:

1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each hydronic boiler.

J. Install pressure gages in the following locations:

1. Discharge of each pressure-reducing valve.
2. Suction and discharge of each pump.

### 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. 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 SCALE-RANGE SCHEDULE

A. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F.

### 3.5 PRESSURE-GAGE SCALE-RANGE SCHEDULE

A. Scale Range for Heating, Hot-Water Piping: 0 to 30 psi.

B. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.

**END OF SECTION 230519**

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## **SECTION 230523 - GENERAL-DUTY VALVES 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 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.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of valve indicated.

#### **1.4 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.

#### **1.5 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.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL REQUIREMENTS FOR VALVES**

- A. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- B. Valve Sizes: Same as upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
1. Gear Actuator: For quarter-turn valves NPS 6 and larger.
  2. Handwheel: For valves other than quarter-turn types.
  3. Handlever: For quarter-turn valves NPS 5 and smaller except plug valves.
  4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.
- D. Valves in Insulated Piping: With 2-inch 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.
- E. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves.
  2. Grooved: With grooves according to AWWA C606.
  3. Threaded: With threads according to ASME B1.20.1.
- F. Valve Bypass and Drain Connections: MSS SP-45.
- G. The manufacturer's name and valve pressure rating shall appear on the outside of the valve body.

### **2.2 BRONZE BALL VALVES**

- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Conbraco Industries, Inc.; Apollo Valves.



- b. Crane Co.; Crane Valve Group; Crane Valves.
- c. Hammond Valve.
- d. Milwaukee Valve Company.
- e. NIBCO INC.
- f. Red-White Valve Corporation.
- g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig.
- c. CWP Rating: 600 psig.
- d. Body Design: Two piece.
- e. Body Material: Bronze.
- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Bronze.
- i. Ball: Chrome-plated brass.
- j. Port: Full.

**2.3 IRON, SINGLE-FLANGE BUTTERFLY VALVES**

A. 150 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Bray Controls; a division of Bray International.
- b. Crane Co.; Crane Valve Group; Jenkins Valves.
- c. Crane Co.; Crane Valve Group; Stockham Division.
- d. DeZurik Water Controls.
- e. Hammond Valve.
- f. Milwaukee Valve Company.
- g. NIBCO INC.

2. Description:

- a. Standard: MSS SP-67, Type I.
- b. CWP Rating: 150 psig.
- c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
- d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
- e. Seat: EPDM.
- f. Stem: One- or two-piece stainless steel.
- g. Disc: Aluminum bronze or nickel plated.

**2.4 BRONZE LIFT CHECK VALVES**

A. Class 125, Lift Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Hammond Valve.
  - b. Milwaukee Valve Company.
  - c. Mueller Steam Specialty; a division of SPX Corporation.
  - d. NIBCO INC.
  - e. Red-White Valve Corporation.
  
2. Description:
  - a. Standard: MSS SP-80, Type 2.
  - b. CWP Rating: 200 psig.
  - c. Body Design: Vertical flow.
  - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
  - e. Ends: Threaded.
  - f. Disc: NBR, PTFE, or TFE.

## 2.5 BRONZE SWING CHECK VALVES

### A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 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. Milwaukee Valve Company.
  - f. NIBCO INC.
  - g. Red-White Valve Corporation.
  
2. Description:
  - a. Standard: MSS SP-80, Type 4.
  - b. CWP Rating: 200 psig.
  - c. Body Design: Horizontal flow.
  - d. Body Material: ASTM B 62, bronze.
  - e. Ends: Threaded.
  - f. Disc: PTFE or TFE.

## 2.6 BRONZE GLOBE VALVES

### A. Class 125, Bronze Globe Valves with Bronze Disc:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Crane Co.; Crane Valve Group; Crane Valves.
  - b. Crane Co.; Crane Valve Group; Stockham Division.

- c. Hammond Valve.
- d. Milwaukee Valve Company.
- e. NIBCO INC.

2. Description:

- a. Standard: MSS SP-80, Type 1.
- b. CWP Rating: 200 psig.
- c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
- d. Ends: Threaded.
- e. Stem and Disc: Bronze.
- f. Packing: Asbestos free.
- g. Handwheel: Malleable iron, bronze, or aluminum.

## **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 check valves for proper direction of flow and as follows:
  - 1. Swing Check Valves: In horizontal position with hinge pin level.
  - 2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
  - 3. Lift Check Valves: With stem upright and plumb.

- F. Install shutoff valves in all branch lines at or near header and at each automatic valve location.
- G. Vents and Drains: All required vents and drains may not be shown on the Contract Drawings. Install 3/4-inch nominal size vent and drain valves in piping systems 1-inch and larger. Install line size vent and drain valves in piping systems 3/4 inch and smaller. Locate vents at high points of each line and/or branch connection. Locate drains at low points. Use piping materials specified for each service. Cap all vents and drains.
  - 1. Use gate or ball valve with threaded hose adapter and chained cap. Strainer blowdown valves shall be same size as strainer blowdown connection.

### 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. 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 valves.
  - 4. Pump-Discharge Check Valves:
    - a. NPS 2 and Smaller: Bronze swing check valves with nonmetallic disc.
    - b. NPS 2-1/2 and Larger: iron, center-guided, 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. See drawing valve schedule for valve application requirements.
- D. Select valves, except wafer types, with the following end connections:
  - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated.
  - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  - 3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
  - 4. For Steel Piping, NPS 2 and Smaller: Threaded ends.

**END OF SECTION 230523**

## **SECTION 230529 - 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 01 Specification Sections, apply to this Section.

#### **1.2 DEFINITIONS**

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Hangers and supports for HVAC 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 supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
  - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: None.
- B. Delegated-Design Submittal: For trapeze hangers 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. Detail fabrication and assembly of trapeze hangers.
  - 2. Design Calculations: Calculate requirements for designing trapeze hangers.

#### **1.5 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: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon 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 THERMAL-HANGER SHIELD INSERTS

- 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. Carpenter & Paterson, Inc.
2. Clement Support Services.
3. ERICO International Corporation.
4. National Pipe Hanger Corporation.
5. PHS Industries, Inc.
6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
7. Piping Technology & Products, Inc.
8. Rilco Manufacturing Co., Inc.
9. Value Engineered Products, Inc.

- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

- B. Mechanical-Expansion Anchors: Insert-wedge-type, 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.

## 2.5 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

## 2.6 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, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 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. 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 powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
  - G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
  - H. 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.
  - I. Install lateral bracing with pipe hangers and supports to prevent swaying.
  - J. 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 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.
  - K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
  - L. 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.
  - M. 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 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 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: 12 inches long and 0.048 inch thick.
  - b. NPS 4: 12 inches long and 0.06 inch thick.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### 3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Provide lateral bracing, to prevent swaying, for equipment supports.

### 3.3 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/D1.1M 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 so contours of welded surfaces match adjacent contours.

### 3.4 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.

### 3.5 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.
- 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.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

### 3.6 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 thermal-hanger shield inserts for insulated piping and tubing.
- G. 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.
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
  - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, 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 noninsulated, stationary pipes NPS 3/4 to NPS 8.
  - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
  - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
  - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  - 14. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.

- H. 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.
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- I. 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 for heavy loads.
  2. Steel Clevises (MSS Type 14): For 120 to 450 deg F 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 piping installations.
- J. 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.
    - b. Medium (MSS Type 32): 1500 lb.
    - c. Heavy (MSS Type 33): 3000 lb.
  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.
- K. 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.
- 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-103 for metal framing system selections and applications that are not specified in piping system Sections.
- N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

**END OF SECTION 230529**

## **SECTION 230553 - 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 ACTION SUBMITTALS**

- A. Product Data: None.

#### **1.3 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. Plastic Labels for Equipment:
  - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having 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.
  - 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-fourths 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), plus the Specification Section number and title where equipment is specified.

## 2.2 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 high.

## **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: Painting of piping is specified in Division 09.
- B. 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.
- C. Pipe Label Color Schedule:
1. Yellow background color with black letters.

**END OF SECTION 230553**

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## **SECTION 230593 - 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 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.

#### **1.3 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: Within 30 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. Certified TAB reports.

#### **1.4 QUALITY ASSURANCE**

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC NEBB or TABB.
  - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC NEBB or TABB.
  - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC NEBB or TABB as a TAB technician.
- B. 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.
- C. TAB Report Forms: Use standard TAB contractor's forms approved by Architect.
- D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

- E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- F. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

### 1.5 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.

### 1.6 COORDINATION

- A. Notice: Provide seven 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 Used)**

## **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 and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 233113 "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 strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
  - K. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
  - L. Examine system pumps to ensure absence of entrained air in the suction piping.
  - M. Examine operating safety interlocks and controls on HVAC equipment.
  - N. 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" NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" 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 Section 233300 "Air Duct Accessories."
  3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "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 inch-pound (IP) 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. For variable-air-volume systems, develop a plan to simulate diversity.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. 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.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling-unit components.
- K. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

### 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 Owner 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 will 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 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.

### 3.7 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 Owner and comply with requirements in Section 232123 "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.

### 3.8 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.

### 3.9 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

### 3.10 PROCEDURES FOR BOILERS

- A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

### 3.11 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 electric heating coil:
  - 1. Nameplate data.
  - 2. Airflow.



3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. 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.

### 3.12 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 10 percent.
2. Air Outlets and Inlets: Plus or minus 10 percent.
3. Heating-Water Flow Rate: Plus or minus 10 percent.

### 3.13 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. Settings for supply-air, static-pressure controller.
  - g. Other system operating conditions that affect performance.

D. 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 o.c.
  - f. Make and model number.
  - g. Face area in sq. ft.
  - h. Tube size in NPS.
  - i. Tube and fin materials.
  - j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
  - a. Air flow rate in cfm.
  - b. Average face velocity in fpm.
  - c. Air pressure drop in inches wg.
  - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
  - e. Return-air, wet- and dry-bulb temperatures in deg F.
  - f. Entering-air, wet- and dry-bulb temperatures in deg F.
  - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
  - h. Water flow rate in gpm.
  - i. Water pressure differential in feet of head or psig.

- j. Entering-water temperature in deg F.
- k. Leaving-water temperature in deg F.
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig.
- n. Refrigerant suction temperature in deg F.

E. 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, and bore.
- h. Center-to-center dimensions of sheave, and amount of adjustments in inches.

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, and bore.
- f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
- g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
- b. Total system static pressure in inches wg.
- c. Fan rpm.
- d. Discharge static pressure in inches wg.
- e. Suction static pressure in inches wg.

F. 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.
- g. Water pressure differential in feet of head or psig.

- h. Required net positive suction head in feet of head or psig.
  - i. Pump rpm.
  - j. Impeller diameter in inches.
  - 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.
  - b. Pump shutoff pressure in feet of head or psig.
  - c. Actual impeller size in inches.
  - d. Full-open flow rate in gpm.
  - e. Full-open pressure in feet of head or psig.
  - f. Final discharge pressure in feet of head or psig.
  - g. Final suction pressure in feet of head or psig.
  - h. Final total pressure in feet of head or psig.
  - i. Final water flow rate in gpm.
  - j. Voltage at each connection.
  - k. Amperage for each phase.

### 3.14 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 Owner.
- 2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Owner.
- 3. Owner 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 will 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.

**END OF SECTION 230593**

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## **SECTION 230713 - DUCT 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 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).

#### **1.3 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.
- C. Install insulation in accordance with MICA National Commercial & Industrial Insulation Standards.

#### **1.4 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.

#### **1.5 COORDINATION**

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- 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.

## 1.6 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 "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum 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. Mineral-Fiber Blanket Insulation (Type D1): Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 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. CertainTeed Corp.; SoftTouch Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Knauf Insulation; Friendly Feel Duct Wrap.
    - d. Manson Insulation Inc.; Alley Wrap.
    - e. Owens Corning; SOFTR All-Service Duct Wrap.
- F. Mineral-Fiber Board Insulation (Type D2): Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. Minimum nominal density of 3 lbs. per cu. ft., and thermal conductivity of not more than 0.23 at 75 degrees F
  - 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. CertainTeed Corp.; Commercial Board.



- b. Fibrex Insulations Inc.; FBX.
- c. Johns Manville; 800 Series Spin-Glas.
- d. Knauf Insulation; Insulation Board.
- e. Manson Insulation Inc.; AK Board.
- f. Owens Corning; Fiberglas 700 Series.

## 2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Adhesives, sealants and protective finishes shall be as recommended by insulation manufacturer for applications specified.
- C. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Adhesive 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."

## 2.3 SEALANTS

- A. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Adhesives, joint sealants and flashing sealants and protective finishes shall be as recommended by insulation and jacketing manufacturer for applications specified.
- C. Sealants 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."

## 2.4 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. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

## 2.5 TAPES

- A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
  - 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. 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.
2. Width: 3 inches.
  3. Thickness: 6.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

## 2.6 SECUREMENTS

### A. Bands:

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 Insulation Systems; Gerrard Strapping and Seals.
  - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch 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.

## **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.

### 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 ducts and fittings.

- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct 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. 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.
  - 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.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
    - 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 duct flanges and fittings.

- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. Exposed Ductwork: Locate insulation and cover seams in least visible locations.

### 3.4 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

### 3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints 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, for 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 and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches 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 overcompress insulation during installation.
    - 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 from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. 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 at 18-foot 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.
5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
  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-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- 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, for 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 and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches 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 overcompress 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 from one edge and one end

of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. 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 at 18-foot 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.
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-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

### 3.7 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. 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 one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.
- D. All reinstallation of insulation removed for inspection shall be performed at no additional cost to the Contract.
- E. Any discovered deviation from the specified materials and methods shall be considered cause for spot-check dismantling of Work to be performed during the preceding day's work. If further deviations are so discovered, the day's Work proceeding that day may be requested to be checked. All dismantling and reinstallation shall be performed at no additional cost to the Contract.
- F. Prior to initiation of work, samples of insulation materials shall be submitted for approval, and a sample of the installation of a section of pipe and fitting demonstrating installation techniques and workmanship shall be witnessed and approved.

### 3.8 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 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.

### 3.9 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- #### A.
- Insulation materials and thicknesses are identified in schedule on drawings. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

**END OF SECTION 230713**

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## **SECTION 230716 - HVAC EQUIPMENT 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 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. LEED Submittals:
  - 1. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
  - 2. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products 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."

#### **1.3 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.
- C. Install insulation in accordance with MICA National Commercial & Industrial Insulation Standards.

#### **1.4 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.

## 1.5 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

## 1.6 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 "Equipment 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. Calcium Silicate (Type E1):
  - 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. Industrial Insulation Group (IIG); Thermo-12 Gold.
  - 2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
  - 3. Comply with ASTM C 533. Minimum dry density of 12.5 lbs. per cu. ft., thermal conductivity of not more than 0.44 at 300 degrees F, maximum water absorption of 90% by volume, minimum compressive strength 140 psi at 5% deformation, rated for service range of 0 degrees F to 1,200 degrees F. Material to be visually coded or marked to indicate it is asbestos free.

- G. Mineral-Fiber, Pipe and Tank Insulation (Type E9): Mineral or glass fibers bonded with a thermosetting resin. Semirigid 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. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
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. CertainTeed Corp.; CrimpWrap.
    - b. Johns Manville; MicroFlex.
    - c. Knauf Insulation; Pipe and Tank Insulation.
    - d. Manson Insulation Inc.; AK Flex.
    - e. Owens Corning; Fiberglas Pipe and Tank Insulation.

## 2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
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. Ramco Insulation, Inc.; Super-Stik.
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
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. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

## 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Adhesives, sealants and protective finishes shall be as recommended by insulation manufacturer for applications specified.
- C. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Adhesives, sealants, mastics and protective finishes shall be as recommended by insulation manufacturer for applications specified.

## 2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
  1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  2. Adhesives, sealants and protective finishes shall be as recommended by insulation manufacturer for applications specified.

## 2.6 SEALANTS

- A. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Adhesives, joint sealants and flashing sealants and protective finishes shall be as recommended by insulation manufacturer for applications specified.

## 2.7 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket (J1): 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - 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.

## 2.8 TAPES

- A. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
  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. ABI, Ideal Tape Division; 370 White PVC tape.
    - b. Compac Corporation; 130.
    - c. Venture Tape; 1506 CW NS.

2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

## 2.9 SECUREMENTS

### A. Bands:

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 Insulation Systems; Gerrard Strapping and Seals.
  - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch 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-diameter shank, length to suit depth of insulation indicated.
  - 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) 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-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
  - 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) 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, securely in position indicated when self-locking washer is in place.
  - 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) 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 thick by 2 inches square.
  - c. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum or Stainless steel to match duct construction, fully annealed, 0.106-inch-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, securely in position indicated when self-locking washer is in place.
  - 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) GEMCO; Nylon Hangers.
    - 2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
  - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
  - c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
  - 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, securely in position indicated when self-locking washer is in place.
  - 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) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers, Series.
    - 2) GEMCO; Peel & Press.
    - 3) Midwest Fasteners, Inc.; Self Stick.

- b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - c. Spindle: Copper- or zinc-coated, low-carbon steel, Aluminum or Stainless steel to match duct construction, fully annealed, 0.106-inch-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-thick, galvanized-steel, aluminum or stainless-steel sheet to match duct construction, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- 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) 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-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- 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) GEMCO.
    - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

## **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. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. 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. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment 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. 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.
  - 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 jackets as follows:
  - 1. Draw jacket tight and smooth.



2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
    - 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.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- O. 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. Manholes.
  5. Handholes.
  6. Cleanouts.
  7. Unions
  8. Flanges
  9. Strainers
  10. Valves
- P. When insulating control valves, strainers, and any other devices requiring frequent access, the insulation shall be fit in such a way that there is an access section which can be readily removed and replaced without damaging adjacent insulation. If a different insulating material is used for boxing in control valve assemblies, etc., the thickness of the insulation shall be adjusted to provide the specified thermal resistance.
- Q. In systems with rigid insulation, slip joints shall be installed every 25-30 feet for thermal expansion. They shall overlap and be caulked according to the jacket manufacturer's installation recommendation. On cold piping, flexible fiberglass insulation shall separate the rigid insulation pieces at the slip joint

### 3.4 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, 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 from insulation end joints, and 16 inches o.c. in both directions.
  - d. Do not overcompress 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 prestressed 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 from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed 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 o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches.
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.

### 3.5 FIELD-APPLIED JACKET INSTALLATION

A. 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 laps at longitudinal seams and 3-inch-wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's 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.

### 3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections: 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 three location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.
- D. All reinstallation of insulation removed for inspection shall be performed at no additional cost to the Contract.
- E. Any discovered deviation from the specified materials and methods shall be considered cause for spot-check dismantling of Work to be performed during the preceding day's work. If further deviations are so discovered, the day's Work proceeding that day may be requested to be checked. All dismantling and reinstallation shall be performed at no additional cost to the Contract.

### 3.7 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.
- B. Insulate indoor and outdoor equipment that is not factory insulated.

Service	Insulation Type	Insulation Thickness	Field Applied Jacket Type
Hot Water Expansion Tank	E9 or E1	1.5"	J2
Hot Water Air Separator	E9 or E1	1.5"	J2

**END OF SECTION 230716**

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## **SECTION 230719 - HVAC 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 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).

#### **1.3 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 and inspecting 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.
- C. Install insulation in accordance with MICA National Commercial & Industrial Insulation Standards.

#### **1.4 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.

#### **1.5 COORDINATION**

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in "Hangers and Supports for HVAC Piping and Equipment."
- 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.

## 1.6 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" 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. Flexible Elastomeric Insulation (Type I5): Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
  - 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. Aeroflex USA, Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
  - 2. Flexible closed cell, minimum nominal density of 5.5 lbs. per cu. ft., thermal conductivity of not more than 0.28 at 75 degrees F, maximum water vapor permeability of 0.08 perm-in, maximum water absorption of 1% by weight, rated for service range of -20 degrees F to 220 degrees F.
- G. Mineral-Fiber, Preformed Pipe Insulation (Type I2):
  - 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. Fibrex Insulations Inc.; Coreplus 1200.
    - b. Johns Manville; Micro-Lok.
    - c. Knauf Insulation; 1000-Degree Pipe Insulation.
    - d. Manson Insulation Inc.; Alley-K.

- e. Owens Corning; Fiberglas Pipe Insulation.
- 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. Thermal conductivity of not more than 0.23 at 75 degrees F.
- 3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article. Thermal conductivity of not more than 0.23 at 75 degrees F.

## 2.2 INSULATING CEMENTS

- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
  - 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. Ramco Insulation, Inc.; Super-Stik.
- B. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.
  - 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. Ramco Insulation, Inc.; Ramcote 1200 and Quik-Cote.

## 2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Adhesives, sealants and protective finishes shall be as recommended by insulation and jacket manufacturer for applications specified.
- C. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
  - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  - 2. Adhesives, sealants, mastics and protective finishes shall be as recommended by insulation and jacket manufacturer for applications specified.

## 2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  2. Adhesives, sealants and protective finishes shall be as recommended by insulation manufacturer for applications specified.

## 2.6 SEALANTS

- A. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Adhesives, joint sealants and flashing sealants and protective finishes shall be as recommended by insulation and jacket manufacturer for applications specified.

## 2.7 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. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
    - a. Products: Subject to compliance with requirements, provide the following:
      - 1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

## 2.8 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. PVC Jacket (J1): 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - 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 fitting covers to match jacket if available; otherwise, field fabricate.
  - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Metal Jacket:

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. 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 (J2): Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  - a. Factory cut and rolled to size.
  - b. Moisture Barrier for Indoor Applications: 2.5-mil-thick polysurlyn.
  - c. Moisture Barrier for Outdoor Applications: 2.5-mil-thick polysurlyn.
  - d. Factory-Fabricated Fitting Covers:
    - 1) Same material, finish, and thickness as jacket.
    - 2) Preformed 2-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.

**2.9 TAPES**

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
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. 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.
  2. Width: 3 inches.

3. Thickness: 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - 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.
  2. Width: 3 inches.
  3. Thickness: 6.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch 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. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
    - a. ABI, Ideal Tape Division; 370 White PVC tape.
    - b. Compac Corporation; 130.
    - c. Venture Tape; 1506 CW NS.
  2. Width: 2 inches.
  3. Thickness: 6 mils.
  4. Adhesion: 64 ounces force/inch in width.
  5. Elongation: 500 percent.
  6. Tensile Strength: 18 lbf/inch in width.

## 2.10 SECUREMENTS

### A. Bands:

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 Insulation Systems; Gerrard Strapping and Seals.
  - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 3/4 inch wide with wing seal.
  3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch 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. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

## **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.
  3. 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 apply to insulation.
- C. 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. 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-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches on center.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. 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 on center.
    - 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 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. Manholes.
  - 5. Handholes.
  - 6. Cleanouts.
  - 7. Unions
  - 8. Strainers
- Q. In systems with rigid insulation, slip joints shall be installed every 25-30 feet for thermal expansion. They shall overlap and be caulked according to the jacket manufacturer's installation recommendation. On cold piping, flexible fiberglass insulation shall separate the rigid insulation pieces at the slip joint.

### 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 below top of roof flashing.
  - 4. Seal jacket to roof flashing with flashing sealant.
- B. 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.
  - 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

### 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.
  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 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 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.
- E. When insulating control valves, strainers, and any other devices requiring frequent access, the insulation shall be fit in such a way that there is an access section which can be readily removed and replaced without damaging adjacent insulation. If a different insulating material is used for boxing in control valve assemblies, etc., the thickness of the insulation shall be adjusted to provide the specified thermal resistance.

### 3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

- A. Seal longitudinal seams and end joints with manufacturer's 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's 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.

### 3.7 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 on center.
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, 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.

### 3.8 FIELD-APPLIED JACKET INSTALLATION

- A. 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 laps at longitudinal seams and 3-inch-wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- B. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's 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.
- C. Where metal jackets are indicated, install with 2-inch 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 on center and at end joints.

### 3.9 FINISHES

- A. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

### 3.10 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, six locations of fittings, and three locations of 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.
- D. All reinstallation of insulation removed for inspection shall be performed at no additional cost to the Contract.
- E. Any discovered deviation from the specified materials and methods shall be considered cause for spot-check dismantling of Work to be performed during the preceding day's work. If further deviations are so discovered, the day's Work proceeding that day may be requested to be checked. All dismantling and reinstallation shall be performed at no additional cost to the Contract.
- F. Prior to initiation of work, samples of insulation materials shall be submitted for approval, and a sample of the installation of a section of pipe and fitting demonstrating installation techniques and workmanship shall be witnessed and approved.

### 3.11 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. Underground piping.
  - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
  - 4. Hot water piping inside radiation, convector, or cabinet heater enclosures.
  - 5. Piping unions for systems not requiring a vapor barrier.

### 3.12 PIPING INSULATION SCHEDULE

- A. See piping insulation schedule on drawings.

**END OF SECTION 230719**

## **SECTION 230900 - INSTRUMENTATION AND CONTROL 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. 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. Related Sections include the following:
  - 1. Section 230519 "Meters and Gages for HVAC Piping" for measuring equipment that relates to this Section.
- C. Furnish and install all labor, materials, equipment, pneumatic/electronic interfaces and actuation devices, apparatus, software, services, permits and supervision, and all permanent and temporary facilities necessary to provide complete and proper working Direct Digital Control system as indicated on the drawings, called for in the specifications or required by job conditions. Drawings are diagrammatic only. Provide any equipment and labor not specifically referred to herein or on the drawings that are required to meet the functional intent, such as repeaters, routers, bridges, and gateways.

#### **1.3 DEFINITIONS**

- A. Application Specific Controller (ASC): A small programmable controller with limited programming and data management capabilities. Usually designed for a specific application.
- B. BAS: Building Automation System.
- C. DDC: Direct digital control.
- D. I/O: Input/output.
- E. LAN: Local Area Network.
- F. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
- G. MS/TP: Master slave/token passing.
- H. PC: Personal computer.
- I. PID: Proportional plus integral plus derivative.

- J. Primary Programmable Controller (PPC): A controller with custom free-form programming to control I/O points related to specific equipment.
- K. RTD: Resistance temperature detector.
- L. Supervisory Logic Controllers (SLC): A controller with custom free-form programming that does not directly control equipment, but gathers, stores, manages, and processes data from lower-level supervised controllers. Communicates on the network peer-to-peer with Primary Programmable Controllers. Sometimes called an Interface Manager Controller (IMC).

#### 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 20 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 10 seconds.
  - 5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
  - 6. Emergency Shutdown Response Time: Shut off equipment within 10 seconds of command.
  - 7. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
  - 8. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second. Scan and update process values and adjust setpoints as follows:
    - a. Room temperature.
    - b. Other variables with PI control.
    - c. Every 10 minutes for:
      - 1) Outside air temperature.
  - 9. 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.
    - b. Water Pressure: Plus or minus 2 percent of full scale.
    - c. Space Temperature: Plus or minus 1 deg F.
    - d. Temperature Differential: Plus or minus 0.25 deg F.
- B. Communications protocol: BACnet protocol per the latest version of ASHRAE Standard 135 and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
- C. Engineering units: English.

- D. Provide at least 10% spare I/O connections on each controller.
- E. Components shall operate within 32 deg F to 122 deg F and 5-85% relative humidity, non-condensing.

### 1.5 SCOPE OF WORK

- A. Tie all new equipment into the existing DDC control system with control points, alarms, and monitoring points similar to the existing equipment. Equipment included within this scope includes:
  - 1. Building hot water boiler system.
  - 2. Ductless Split.
  - 3. Snow melt system.
  - 4. Hot water unit heater.

### 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.
  - 4. Cavitation calculations for modulating valves over 250 deg F and all modulating butterfly valves over 60 deg F.
- 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 for each system showing fans, pumps, coils, dampers, valves, and control devices.
  - 3. Wiring Diagrams: Power, signal, and control wiring. Differentiate between factory and field installed wiring.
  - 4. Wire Tabulation List: wire ID, "to" and "from", and wire color.
  - 5. Details of control panel faces, including controls, instruments, and labeling.
  - 6. Written description of sequence of operation.
  - 7. Schedule of dampers including size, leakage, and flow characteristics.
  - 8. Schedule of valves including flow characteristics.
  - 9. 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.
10. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
11. 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.

#### 1.7 INFORMATIONAL SUBMITTALS

- A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- B. Qualification Data: For Installer and manufacturer.
- C. Field quality-control test reports.
- D. Warranty Certificates

#### 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 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.
  - 6. Programming manuals.
  - 7. Maintenance instructions.
  - 8. Record documents (“as-builts”), including updated schematic diagrams, wiring diagrams, and control sequences.
  - 9. Training documentation.

10. Contact information of service contractor and parts suppliers.
- 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 and installation instructions.
  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, or controller thermostat.

#### 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.
1. Have similar control equipment in service for not less than 5 years.
- 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.
- D. Comply with the following:
1. UL-916; Energy Management Systems.
  2. UL-873; Temperature Indication and Regulating Equipment.
  3. UL-864, Subcategories UUKL, UOXX, UDTZ; Fire Signaling and Smoke Control Systems.
  4. FCC, Part 15, Subpart J, Class A Computing Devices.

#### 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 supply of conditioned electrical branch circuits for control units and operator workstation.
- C. Coordinate equipment with Division 26 to achieve compatibility of communication interfaces.
- D. Coordinate equipment with Division 26 to achieve compatibility with motor starters and annunciation devices.
- E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

### 1.13 WARRANTY

- A. Provide warranty on all parts and labor for one year starting at the date of Substantial Completion.

## **PART 2 - PRODUCTS**

### 2.1 MANUFACTURERS

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

### 2.2 CONTROL SYSTEM

- A. Manufacturers:
  - 1. StruxureWare by Schneider Electric
- 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.

### 2.3 DDC EQUIPMENT



- A. Operator Workstation: Existing StruxureWare building operating system.
- B. Primary Programmable Controllers (PPC): Modular, comprising processor board with custom free-form programmable, nonvolatile, random-access memory; local operator access to plug in diagnostic terminal unit and display panel; integral interface equipment; and backup power source providing a minimum of 72 hours protection of trend data and clock functions.
  - 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.
    - f. Diagnostic software.
    - g. Heartbeat or watchdog timer LED indicating that the controller is operating properly.
  - 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. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
      - 1) Store a minimum of 144 trend values for every I/O point specified to be trended.
      - 2) Upload values of trended points to the operator work station when the value changes or every 15 minutes when the value does not change.
    - c. Remote communications.
    - d. Maintenance management.
    - e. 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. Expandable with add-on expansion I/O modules.

7. Analog-to-digital (A/D) and digital-to-analog (D/A) converter resolution (e.g., 8-bit or 10-bit processor) shall be sufficient to provide the resolution required for the control loops.
- C. Supervisory Logic Controllers (SLC): Modular, comprising processor board with custom free-form programmable, nonvolatile, random-access memory; local operator access to plug in laptop computer; and backup power source providing a minimum of 72 hours protection of trend data and clock functions.
1. Units monitor or control data from supervised application specific controllers; 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, timeclock, trending, and alarm processing.
    - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
    - f. Diagnostic software.
    - g. Heartbeat or watchdog timer LED indicating that the controller is operating properly.
  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.
      - 1) Store a minimum of 144 trend values for every I/O point specified to be trended.
      - 2) Upload values of trended points to the operator work station when the value changes or every 15 minutes when the value does not change.
    - e. Remote communications.
    - f. Maintenance management.

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.
  5. Communication interface card suitable for connecting to the network.
  6. Expandable with add-on expansion I/O modules.
  7. Analog-to-digital (A/D) and digital-to-analog (D/A) converter resolution (e.g., 10-bit or 12-bit processor) shall be sufficient to provide the total resolution required for the control loops.
- D. Application Specific Controllers (ASC): Modular, comprising processor board with electronically programmable, nonvolatile, 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.
    - d. Heartbeat or watchdog timer LED indicating that the controller is operating properly.
  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. Database and Memory Back-Up: All programming defining the functions to be performed by the ASC, including but not limited to application programs and point database within each ASC, shall be protected from loss due to power failure for a minimum of six months. Systems providing non-volatile memory for these functions are preferred. Systems not providing non-volatile memory shall provide a system rechargeable battery backup system sufficient to provide protection for the specified 6-month period. Systems not in compliance shall provide for uninterrupted power to each ASC.
- 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. Systems which command multiple outputs over a single pair of wires, such as power line carrier systems, are not acceptable.
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.
  5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA).
  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.

8. SPDT Output Relays: Indicate status with an LED.
- 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. Control Panels:
1. Provide panel enclosures for all DDC controllers and associated function modules. All controls to be in enclosures without exception.
  2. Provide UL listed cabinets for use with line voltage devices.
  3. NEMA Rating:
    - a. Inside: NEMA-1.
    - b. Outside: NEMA-3R or NEMA-4.

## 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 scheduling with real-time clock. 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. Enclosure: Dustproof rated for operation at 32 to 120 deg F.
  5. Enclosure: Waterproof rated for operation at 40 to 150 deg F.

## 2.5 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, 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.
  - 2. Proportional band shall extend from 2 to 20 percent for 5 psig.
  - 3. Authority shall be 20 to 200 percent.
  - 4. Air-supply pressure of 18 psig, input signal of 3 to 15 psig, and output signal of zero to supply pressure.
  - 5. Gages: 2-1/2 inches in diameter, 2.5 percent wide-scale accuracy, and range to match transmitter input or output pressure.

## 2.6 ELECTRONIC SENSORS AND TRANSMITTERS

- A. General Requirements:
  - 1. Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
  - 2. For wall, immersion, or duct mounting as required.
    - a. Architectural housing for office space mounting.
    - b. Weatherproof/sunshield housing for outdoors.
    - c. Thermowell housing for water applications.
      - 1) Non-corrosive fluids below 250 deg F: brass or stainless steel.
      - 2) Other applications: 300 series stainless steel.
    - d. Protective housing for duct mounting.

3. The sensor/transducer shall be selected to withstand ambient conditions, including moisture or condensation and transient conditions for temperatures, pressures, humidities, etc.
4. Transducers may be supplied as an integral unit with the field sensor, or as part of the controller.
5. The sensor/transducer shall be appropriately selected to most closely match the expected sensing range.
6. Use a transmitter where the sensor is more than 100 feet from its associated controller, there is excessive electrical noise present, or the controller cannot accept direct sensor input, a 4-20mA type.
7. All temperature and humidity sensors shall be of the same manufacturer.
8. All pressure transmitters and transducers shall be of the same manufacturer.

**B. Thermistor Temperature Sensors and Transmitters:**

1. Accuracy: Plus or minus 0.5 deg F at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.

**C. RTDs and Transmitters:**

1. Accuracy: Plus or minus 0.2 percent at calibration point.
2. Wire: Twisted, shielded-pair cable.
3. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.

**D. Pressure Transmitters/Transducers:**

1. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
2. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
3. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
4. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

**2.7 STATUS SENSORS**

- A. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.
- B. 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.
- C. 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.

- D. 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.
- E. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- F. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- G. 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 NTP fitting, rated for 300 psig for chilled water applications or 150 psig other applications.

## 2.8 THERMOSTATS

- A. Low-Voltage, On-Off Thermostats (Type T3): NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, visible temperature reading, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.
- B. Line-Voltage, On-Off Thermostats (Type T4): Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; visible temperature reading, listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F 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.
- C. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

## 2.9 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action. Stroke time for 90-degree rotation 90 seconds or less for major equipment and 6 minutes or less for terminal equipment. Provide position feedback potentiometers connected to controller for closed loop control on major equipment analog control loops. Provide pilot positioners.
  - 1. Comply with requirements in Section 230513 "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: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.

4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque. Stroke time for 90-degree rotation 90 seconds or less for major equipment and 6 minutes or less for terminal equipment. Provide position feedback potentiometers connected to controller for closed loop control on major equipment analog control loops. Provide pilot positioners.
1. Available Manufacturers:
    - a. Belimo Aircontrols (USA), Inc.
  2. Valves: Size for torque required for valve close off at maximum pump differential pressure. Provide operators and pilot positioners with linkages and brackets for mounting on control valve. Design mounting and/or support to provide no more than 5% hysteresis in either direction.
  3. Coupling: V-bolt and V-shaped, toothed cradle.
  4. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
  5. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
  6. Power Requirements (Two-Position Spring Return): 24-V ac.
  7. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
  8. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
  9. Temperature Rating: Minus 22 to plus 122 deg F.
  10. Run Time: 12 seconds open, 5 seconds closed.
  11. Provide external adjustable stops on damper actuators.

## 2.10 CONTROL VALVES

- A. Available Manufacturers:
1. Danfoss Inc.; Air Conditioning & Refrigeration Div.
  2. Erie Controls.
  3. Hayward Industrial Products, Inc.
  4. Magnatrol Valve Corporation.
  5. Neles-Jamesbury.
  6. Parker Hannifin Corporation; Skinner Valve Division.
  7. Pneuline Controls.
  8. Sauter Controls Corporation.
  9. Honeywell.
  10. Johnson Controls, Inc.
  11. Siebe.
- 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 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 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: 3-psig 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. 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 and 250 deg F operating conditions.
  2. Sizing: 3-psig 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.

## 2.11 ELECTRICAL POWER DEVICES

- A. Transformers:
1. Transformer shall be sized for the total connected load, plus an additional 25 percent of connected load.
  2. Transformer shall be at least 100 VA.
  3. Transformer shall have both primary and secondary fuses.
- B. Power-Line Conditioner:
1. General Power-Line Conditioner Requirements:
    - a. Design to ensure maximum reliability, serviceability and performance.

- b. Overall function of the power-line conditioner is to receive raw, polluted electrical power and purify it for use by electronic equipment. The power-line conditioner shall provide isolated, regulated, transient and noise-free sinusoidal power to loads served.
2. Standards: NRTL listed per UL 1012.
  3. Performance:
    - a. Single phase, continuous, 100 percent duty rated KVA/KW capacity. Design to supply power for linear or nonlinear, high crest factor, resistive and reactive loads.
    - b. Automatically regulate output voltage to within 2 percent or better with input voltage fluctuations of plus 10 to minus 20 percent of nominal when system is loaded 100 percent. Use Variable Range Regulation to obtain improved line voltage regulation when operating under less than full load conditions.
      - 1) At 75 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 35 percent of nominal.
      - 2) At 50 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 40 percent of nominal.
      - 3) At 25 Percent Load: Output voltage automatically regulated to within 3 percent with input voltage fluctuations of plus 10 to minus 45 percent of nominal.
    - c. With input voltage distortion of up to 40 percent, limit the output voltage sine wave to a maximum harmonic content of 5 percent.
    - d. Automatically regulate output voltage to within 2.5 percent when load (resistive) changes from zero percent to 100 percent to zero percent.
    - e. Output voltage returns to 95 percent of nominal level within two cycles and to 100 percent within three cycles when the output is taken from no load to full resistive load or vice-versa. Recovery from partial resistive load changes is corrected in a shorter period of time.
    - f. K Factor: 30, designed to operate with nonlinear, non-sinusoidal, high crest factor loads without overheating.
    - g. Input power factor within 0.95 approaching unity with load power factor as poor as 0.6.
    - h. Attenuate load-generated odd current harmonics 23 dB at the input.
    - i. Electrically isolate the primary from the secondary. Meet isolation criteria as defined in NFPA 70, Article 250-5D.
    - j. Lighting and Surge Protection: Compares to UL 1449 rating of 330 V when subjected to Category B3 (6000 V/3000 A) combination waveform as established by IEEE C62.41.
    - k. Common-mode noise attenuation of 140 dB.
    - l. Transverse-mode noise attenuation of 120 dB.
    - m. With loss of input power for up to 16.6 ms, the output sine wave remains at usable ac voltage levels.
    - n. Reliability of 200,000 hours' MTBF.



- 3) 10 MHz: 21 dB.
- 4) 100 MHz: 36 dB.

b. Line to Ground:

- 1) 100 kHz: 16 dB.
- 2) 1 MHz: 55 dB.
- 3) 10 MHz: 81 dB.
- 4) 100 MHz: 80 dB.

7. Unit shall have LED status indicator that extinguishes to indicate a failure.
8. Unit shall be listed by an NRTL as a transient voltage surge suppressor per UL 1449, and as an electromagnetic interference filter per UL 1283.
9. Unit shall not generate any appreciable magnetic field.
10. Unit shall not generate an audible noise.

D. DC Power Supply:

1. Plug-in style suitable for mating with a standard eight-pin octal socket. Include the power supply with a mating mounting socket.
2. Enclose circuitry in a housing.
3. Include both line and load regulation to ensure a stable output. To protect both the power supply and the load, power supply shall have an automatic current limiting circuit.
4. Performance:
  - a. Output voltage nominally 25-V dc within 5 percent.
  - b. Output current up to 100 mA.
  - c. Input voltage nominally 120-V ac, 60 Hz.
  - d. Load regulation within 0.5 percent from zero- to 100-mA load.
  - e. Line regulation within 0.5 percent at a 100-mA load for a 10 percent line change.
  - f. Stability within 0.1 percent of rated volts for 24 hours after a 20-minute warmup.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that power supply is available to control units and operator workstation.
- B. Verify that pneumatic piping and duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

### **3.2 SYSTEM DESIGN**

A. General Criteria:

1. Size all control devices to properly supply and/or operate and control the apparatus served.

2. Provide control devices suitable for the environment in which they will operate:
  - a. All devices shall be constructed to withstand system temperatures and pressures.
  - b. Devices used in outdoor ambient conditions shall be constructed to withstand those conditions or shall be suitably weather protected.
  - c. Devices in corrosive environments shall be constructed of materials to withstand the effects of that environment.

**B. Control Valves**

1. Sizing/selection criteria:
  - a. Valves with pressure drop greater than 50% of upstream pressure shall have sound reduction trim.
  - b. Water Service:
    - 1) Characteristic: equal percentage for two-way valves; linear for three way valves.
    - 2) Select control valves based on pressure drop calculations based on  $C_v$  values at 100% stroke.
    - 3) Heating: globe type, selected for a minimum of 25% of equipment subcircuit pressure drop but no more than maximum available pump head allowing 2 psi pressure drop for balancing valve.
    - 4) Cooling: globe or butterfly type, selected for minimum of 10% of equipment subcircuit pressure drop, but not more than maximum pump head allowing minimum 2 psi pressure drop for balancing valve. Modulating butterfly valves shall be high performance type.

**3.3 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 above the floor.
  1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
  2. Meet ADA requirements.
  3. Locate temperature sensors away from direct sunlight, diffuser air streams, and heat sources.
  4. Install thermostats and temperature sensors mounted on outside walls on insulated subbases.
  5. Install devices with visible readouts where the display can be easily read.
- D. Install labels and nameplates to identify control components according to Section 230553 "Identification for HVAC Piping and Equipment."

- E. Install hydronic instrument wells, valves, and other accessories according to Section 232116 Hydronic Piping Specialties."
- F. Provide power wiring to each component requiring power, such as control panels. Use circuits dedicated for controls. For equipment on emergency power, use emergency power circuits for their controllers.
- G. Mount all control devices in accessible locations.
- H. Application of Controllers:
  - 1. All major equipment and systems shall have independent controllers.
  - 2. Primary Process Controllers (PPCs) shall be used for the following:
    - a. Heating water system.
  - 3. Supervisory Logic Controllers (SLCs) shall be used for the following:
    - a. Supervising Application Specific Controllers (ASCs)
  - 4. Application Specific Controllers (ASCs) shall be used for the following:
    - a. Terminal heating and cooling equipment.
    - b. VAV boxes.
    - c. Unitary equipment up to 15 tons cooling capacity.
    - d. Pumps.
    - e. Fans.
- I. Interposing Relays:
  - 1. Provide interposing relays necessary for interfacing to low voltage outputs with 120 VAC or line voltage motor control.
    - a. Use Type C horsepower rated interposing relays for motors and electric heaters.
    - b. Use Type K interposing relays for other general purpose use.
- J. Well-Mounted Sensors:
  - 1. Install thermal conducting compound.
  - 2. In pipe 2 ½ inches and smaller: install at elbow with tee fitting with well pointed upstream. Minimum 2" tee size.
  - 3. In pipe 3 inches and larger: install the element in the flow.

### **3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION**

- A. Install raceways, boxes, and cabinets according to Division 26.
- B. Install building wire and cable according to Division 26.
- C. Installation of signal and communication cable.

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
  2. Install cable in conduit in the following locations:
    - a. Exposed areas, such as mechanical rooms and electrical rooms.
    - b. Inaccessible concealed spaces, such as above drywall ceilings and in concrete or furred walls.
  3. Install exposed cable in raceway.
  4. Install concealed cable in raceway.
  5. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
  6. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
  7. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
  8. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
  9. Route wires parallel or perpendicular to the building structural elements.
  10. Do not route wires across telephone equipment areas.
  11. In enclosures, install wiring in plastic track.
  12. In controllers, wrap and secure all wiring.
  13. Install wires at least 3 inches away from hot surfaces, such as steam and hot water pipes.
- 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.
- F. Where the sensor voltage exceeds the controller's allowed input voltage, modify the circuit with resistor(s) so that the input voltage to the controller is as high as practical and below the controller's limit.
- G. Provide transient voltage surge protection according to Division 26.
- H. For equipment powered by emergency power, provide power to the equipment's controller from an emergency power panel.

### 3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. 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. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
5. Test each point through its full operating range to verify that safety and operating control set points are as required.
6. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions. Verify response times.
7. Test each system for compliance with sequence of operation. Provide one week notice before scheduled test to allow Engineer to witness test.
8. Test software and hardware interlocks.
9. Test all alarms, including any phone calls or e-mail alarm messages. Verify response times.
10. Verify trends are being recorded.
11. Verify occupancy schedule with building users.
12. Print reports.
13. Test all operator access points to the network, such as the operator work station, laptop computer from each controller plug-in, modem access, and web access.
14. Test all interactions with other systems, such as fire alarm, lighting, and security systems.
15. Verify proper electrical voltages and amperages.
16. Verify all circuits are free from shorts, grounds or faults.

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 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.
11. Tune all PI control loops.



- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

### 3.6 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
  - a. Use manufacturer's linearity curve to linearize the signal from each sensor.
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. Factory calibration does not replace field calibration.
4. Control System Inputs and Outputs:
  - a. Check analog inputs at 0, 50, and 100 percent of span.
  - b. Check analog outputs using milliamperemeter 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.

### 3.7 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.
1. The first training session, minimum 4 hours, shall take place just prior to Substantial Completion. Training shall include system operation, maintenance procedures, and operating the system software. Submit O&M manuals at least one week prior to training session.

**END OF SECTION 230900**

## **SECTION 231123 - FACILITY NATURAL-GAS 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 DEFINITIONS**

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, 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.

#### **1.3 PERFORMANCE REQUIREMENTS**

- A. Minimum Operating-Pressure Ratings:
  - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
  - 2. Service Regulators: 100 psig minimum unless otherwise indicated.
- B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: None.

#### **1.5 QUALITY ASSURANCE**

- A. Steel Support 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.
- 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.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.
- B. 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.
- C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

## 1.7 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
  - 1. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
  - 2. Do not proceed with interruption of natural-gas service without Owner's written permission.

## 1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces.

## **PART 2 - PRODUCTS**

### 2.1 PIPES, TUBES, AND FITTINGS

- A. Pipe and Fittings: See drawing schedule for pipe and fitting material requirements.

### 2.2 PIPING SPECIALTIES

- A. Appliance Flexible Connectors:
  - 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
  - 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
  - 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
  - 4. Corrugated stainless-steel tubing with polymer coating.
  - 5. Operating-Pressure Rating: 0.5 psig.
  - 6. End Fittings: Zinc-coated steel.
  - 7. Threaded Ends: Comply with ASME B1.20.1.

8. Maximum Length: 72 inches
- B. Y-Pattern Strainers:
1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
  2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
  3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
  4. CWP Rating: 125 psig.
- C. Basket Strainers:
1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
  2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
  3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
  4. CWP Rating: 125 psig.
- D. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

## 2.3 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for natural gas.
- B. 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.

## 2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
1. CWP Rating: 125 psig.
  2. Threaded Ends: Comply with ASME B1.20.1.
  3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
  4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
  6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
1. CWP Rating: 125 psig.
  2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
  3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
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. BrassCraft Manufacturing Company; a Masco company.
    - b. Conbraco Industries, Inc.; Apollo Div.
    - c. Lyall, R. W. & Company, Inc.
    - d. McDonald, A. Y. Mfg. Co.
    - e. Perfection Corporation; a subsidiary of American Meter Company.
  2. Body: Bronze, complying with ASTM B 584.
  3. Ball: Chrome-plated bronze.
  4. Stem: Bronze; blowout proof.
  5. Seats: Reinforced TFE; blowout proof.
  6. Packing: Threaded-body packnut design with adjustable-stem packing.
  7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Bronze Plug Valves: MSS SP-78.
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. Lee Brass Company.
    - b. McDonald, A. Y. Mfg. Co.
  2. Body: Bronze, complying with ASTM B 584.
  3. Plug: Bronze.
  4. Operator: Square head or lug type with tamperproof feature where indicated.
  5. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  6. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

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. McDonald, A. Y. Mfg. Co.
  - b. Mueller Co.; Gas Products Div.
  - c. Xomox Corporation; a Crane company.
2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Operator: Square head or lug type with tamperproof feature where indicated.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to the International Fuel Gas Code to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with the International Fuel Gas Code requirements for prevention of accidental ignition.

### **3.3 OUTDOOR PIPING INSTALLATION**

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Steel Piping with Protective Coating:
  1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
  2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
  3. Replace pipe having damaged PE coating with new pipe.
- C. Install fittings for changes in direction and branch connections.

- D. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."

### 3.4 INDOOR PIPING INSTALLATION

- A. Comply with the International Fuel Gas Code for installation and purging of natural-gas piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. 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.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- G. Locate valves for easy access.
- H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Verify final equipment locations for roughing-in.
- L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
  - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.



- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- Q. Connect branch piping from top or side of horizontal piping.
- R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- S. Do not use natural-gas piping as grounding electrode.
- T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- U. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 230519 "Meters and Gages for HVAC Piping."
- V. Install sleeves for piping penetrations of walls, ceilings, and floors.
- W. Install sleeve seals for piping penetrations of concrete walls and slabs.
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors.

### 3.5 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- C. Install earthquake valves aboveground outside buildings according to listing.

### 3.6 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Threaded Joints:
  1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
  2. Cut threads full and clean using sharp dies.
  3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
  4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
  5. 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. Welded Joints:
1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
  2. Bevel plain ends of steel pipe.
  3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

### 3.7 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
  3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
  4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
  5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.
- C. Install hangers for horizontal, corrugated stainless-steel tubing with the following maximum spacing and minimum rod sizes:
1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
  2. NPS 1/2: Maximum span, 72 inches; minimum rod size, 3/8 inch.
  3. NPS 3/4 and Larger: Maximum span, 96 inches; minimum rod size, 3/8 inch.
- D. Provide additional intermediate supports as required so deflection of piping does not exceed 1/240 of span.
- E. Support spacings listed above are minimum requirements. Contractor shall provide additional supports as required by codes or authority having jurisdiction at no additional cost to contract.

### 3.8 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

### 3.9 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

### 3.10 PAINTING

- A. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
  - 1. Alkyd System: MPI EXT 5.1D.
    - a. Prime Coat: Alkyd anticorrosive metal primer.
    - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
    - c. Topcoat: Exterior alkyd enamel (gloss).
    - d. Color: Gray.
- B. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
  - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
    - a. Prime Coat: Alkyd anticorrosive metal primer.
    - b. Intermediate Coat: Interior latex matching topcoat.
    - c. Topcoat: Interior latex (semigloss).
    - d. Color: Gray.
- C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

### 3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Test, inspect, and purge natural gas according to the International Fuel Gas Code and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Prior to start-up, Contractor shall verify gas system pressure downstream of gas meter as indicated on plans. If meter pressure is not within  $\pm 5\%$  of pressure indicated on plans, Contractor shall notify the Architect/Engineer and Owner immediately.

1. If a pressure tap is not available for connectors of a gas pressure gauge, one shall be installed at no additional cost to the Contract.
- F. Downstream gas pressure measurement shall be taken within 15 feet of the gas meter discharge.

**3.12 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

**3.13 OUTDOOR AND INDOOR PIPING SCHEDULE**

- A. See pipe and valve schedule on drawings for piping materials schedule

**3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE**

- A. See pipe and valve schedule on drawings for piping materials schedule

**END OF SECTION 231123**

## **SECTION 232113 - 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 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. Chemical treatment.

#### **1.3 INFORMATIONAL SUBMITTALS**

- A. None.

#### **1.4 QUALITY ASSURANCE**

- A. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. 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.
  2. Condensate-Drain Piping: 150 deg F.
  3. Air-Vent Piping: 200 deg F.
  4. 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. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Copper or Bronze Pressure-Seal Fittings:
  - 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. NIBCO INC.
    - b. Viega.
  - 2. Housing: Copper.
  - 3. O-Rings and Pipe Stops: EPDM.
  - 4. Tools: Manufacturer's special tools.
  - 5. Minimum 200-psig working-pressure rating at 250 deg F.
- E. 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.
- H. Grooved Mechanical-Joint Fittings and Couplings:
  - 1. Grooved pipe joining methods are not allowed.

- I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

## 2.4 PLASTIC PIPE AND FITTINGS

- A. PVC Plastic Pipe: ASTM D 1785, with wall thickness as indicated in "Piping Applications" Article.
  - 1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 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 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. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

- a. PVC solvent cement shall have a VOC content of 510 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."

H. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

## 2.6 TRANSITION FITTINGS

A. See specification section 230500 – Common Work Results for HVAC.

## 2.7 DIELECTRIC FITTINGS

A. See specification section 230500 – Common Work Results for HVAC.

# **PART 3 - EXECUTION**

## 3.1 PIPING APPLICATIONS

A. See drawing mechanical piping and valve schedule for piping application requirements.

B. 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, annealed-temper copper tubing with soldered or flared joints.

C. 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.

## 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 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.
- 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 valves according to Section 230523 "General-Duty Valves for HVAC Piping."
- P. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- Q. Install shutoff valve immediately upstream of each dielectric fitting.
- R. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors.
- T. Install sleeve seals for piping penetrations of concrete walls and slabs.
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

### **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 and Smaller: Use dielectric nipples or unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.

### **3.4 HANGERS AND SUPPORTS**

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:
1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
  2. Adjustable roller hangers and spring hangers for individual horizontal piping 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. 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. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 7 feet.
  2. NPS 1: Maximum span, 7 feet.
  3. NPS 1-1/2: Maximum span, 9 feet.
  4. NPS 2: Maximum span, 10 feet.
  5. NPS 2-1/2: Maximum span, 11 feet.
  6. NPS 3 and Larger: Maximum span, 12 feet.
- D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
  2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
  3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
  7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- E. 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.
- F. Support vertical runs at roof, at each floor, and at 10-foot 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. PVC Pressure Piping: Join ASTM D 1785 schedule number, 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.

### 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 ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

### 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, chillers, cooling towers, to specified values.
7. Verify lubrication of motors and bearings.

**END OF SECTION 232113**

## **SECTION 232116 - HYDRONIC 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 ACTION SUBMITTALS**

- A. Product Data: For each type of the following:
1. 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.

#### **1.3 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.

#### **1.4 MAINTENANCE MATERIAL SUBMITTALS**

- A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

#### **1.5 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 at 200 deg F.
  2. Makeup-Water Piping: 80 psig at 150 deg F.
  3. Condensate-Drain Piping: 150 deg F.
  4. Air-Vent Piping: 200 deg F.
  5. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

## 2.2 VALVES

- A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Section 230523 "General-Duty Valves for HVAC Piping."
- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Section 230900 "Instrumentation and Control for HVAC."
- C. Bronze, Calibrated-Orifice, Balancing 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. Armstrong Pumps, Inc.
    - b. Bell & Gossett Domestic Pump.
    - c. Flow Design Inc.
    - d. Gerand Engineering Co.
    - e. Griswold Controls.
    - f. Nexus Valve, Inc.
    - g. Taco.
    - h. Tour & Andersson; available through Victaulic Company.
  - 2. Body: 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. 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, but are not limited to, the following:
    - 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: 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.

## 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, but are not limited to, the following:
  - a. AMTROL, Inc.
  - b. Armstrong Pumps, Inc.
  - c. Bell & Gossett Domestic Pump.
  - d. Nexus Valve, Inc.
  - e. 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. Automatic Air Vents:

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. Armstrong Pumps, Inc.
  - c. Bell & Gossett Domestic Pump.
  - d. Nexus Valve, Inc.
  - e. Taco, Inc.
2. Body: Bronze or cast iron.
3. Internal Parts: Nonferrous.
4. Operator: Noncorrosive metal float.
5. Inlet Connection: NPS 1/2.
6. Discharge Connection: NPS 1/4.
7. CWP Rating: 150 psig.
8. Maximum Operating Temperature: 240 deg F.

### C. Expansion 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. Armstrong Pumps, Inc.
  - c. Bell & Gossett Domestic Pump.
  - d. Taco, Inc.
2. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested after taps are fabricated and shall be labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.
4. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
5. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch- diameter gage glass, and slotted-metal glass guard.

D. Bladder-Type Expansion 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. Armstrong Pumps, Inc.
  - c. Bell & Gossett Domestic Pump.
  - d. Taco, Inc.
2. Tank: Welded steel, rated for 125-psig working pressure and 375 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: Butyl - 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.

E. In-Line Air Separators:

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. 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.
- F. Air Purgers:
- 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. 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. Y-Pattern Strainers:
- 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
  - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
  - 3. Strainer Screen: Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
  - 4. CWP Rating: 125 psig.
- B. Basket Strainers:
- 1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
  - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
  - 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
  - 4. CWP Rating: 125 psig.
- C. 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.
- D. Spherical, Rubber, Flexible Connectors:
1. Body: Fiber-reinforced rubber body.
  2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
  3. Performance: Capable of misalignment.
  4. CWP Rating: 150 psig.
  5. Maximum Operating Temperature: 250 deg F.

## **PART 3 - EXECUTION**

### **3.1 VALVE APPLICATIONS**

- A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
- B. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- C. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- D. 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.

### **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 automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.
- D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.
- E. Install expansion tanks above the air separator. 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.

**END OF SECTION 232116**

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## **SECTION 232123 - 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 DEFINITIONS**

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.

#### **1.3 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.
  - 4. Include NPSH curve when specified.
  - 5. Certified dimension prints showing all necessary details of construction.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

#### **1.5 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.

### **PART 2 - PRODUCTS**

#### **2.1 CLOSE-COUPLED, IN-LINE 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. Aurora Pump; Division of Pentair Pump Group.
  3. Bell & Gossett
  4. Crane Pumps & Systems.
  5. Grundfos Pumps Corporation.
  6. TACO Incorporated.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; 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, replaceable bronze wear rings, and threaded companion-flange 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.
  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: Permanently lubricated ball bearings.
- 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 Section 230513 "Common Motor Requirements for HVAC Equipment."
    - a. Enclosure: Open, dripproof.

## 2.2 PUMP SPECIALTY FITTINGS

- A. Triple-Duty Valve:
1. Angle or straight pattern.
  2. 175-psig pressure rating, cast-iron body, pump-discharge fitting.
  3. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
  4. Brass gage ports with integral check valve and orifice for flow measurement.
  5. Supplied by pump manufacturer.

### 2.3    INLINE CIRCULATORS

- 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
  - 2.     ITT/Bell and Gossett
  - 3.     Taco, Inc.
- B.    Type: In-line circulating pump.
- C.    Casing: Cast-iron, rated for 125 psi working pressure.
- D.    Impeller: Cadmium-plated steel or Bronze; plastic not permitted.
- E.    Shaft: Alloy steel with integral thrust collar and 2 oil lubricated bronze sleeve bearings.
- F.    Seal: Carbon rotating against stationary ceramic seat.

## **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.    Comply with HI 1.4.
- B.    Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C.    Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D.    Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and elastomeric hangers of size required to support weight of in-line pumps.
  - 1.     Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

### 3.3 ALIGNMENT

- A. Engage a factory-authorized service representative to 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.

### 3.4 CONNECTIONS

- A. 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 equal to or greater than diameter of pump nozzles.
- E. Install check, shutoff, and throttling valves on discharge side of pumps.
- F. Install Y-type strainer and shutoff valve on suction side of pumps.
- G. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.
- H. Ground equipment according to Division 26,
- I. Connect wiring according to Division 26.
- J. Threaded piping may be connected to flanged pumps with a threaded/flanged valves equal to Webstone "The Isolator" uni-flange ball valve.

### 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. 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.
  8. Ensure pumps operate at specified system fluid temperatures without vapor binding or cavitation and are non-overloading in both parallel and individual operation.

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

**END OF SECTION 232123**

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## **SECTION 232513 - WATER TREATMENT FOR CLOSED-LOOP HYDRONIC 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 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.
- B. RO: Reverse osmosis.
- C. TSS: Total suspended solids are solid materials, including organic and inorganic, that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:
  - 1. No product data submittals required.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. None.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

#### **1.6 QUALITY ASSURANCE**

- A. HVAC Water-Treatment Service Provider Qualifications: A minimum five years experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

#### **1.7 MAINTENANCE SERVICE**

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion and scale formation for hydronic piping and equipment. 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. Basis-of-Design Product: Subject to compliance with requirements, provide Nalco; an Ecolab company or comparable, approved product.

### **2.2 PERFORMANCE REQUIREMENTS**

- A. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.
- B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. Closed hydronic systems, including hot-water heating, 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. TSS: 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 zero organisms/mL.
    - e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

## 2.3 MANUAL CHEMICAL-FEED EQUIPMENT

- A. Bypass Feeders: Steel, with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 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: 2 gal.
  2. Minimum Working Pressure: 125 psig.

## 2.4 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 "Performance Requirements" Article.

## 2.5 GLYCOL WATER TREATMENT

- A. Acceptable Manufacturers:
1. Dow Chemical: DowTherm SR-1
  2. Dupont: TELAR
  3. Nalco: Freeze-Shield 2812
  4. Union Carbide: Ucartherm
- B. Mix treated ethylene glycol with water in ratio of 50% glycol by volume. The water shall meet manufacturer's requirements.
- C. Glycol shall include corrosion inhibitors and stability compounds.
- D. Provide manual fill pump to be capable of 5 to 10 GPM at 10 psig fill pressure.

## **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 seismic restraints for equipment and floor-mounting accessories and anchor to building structure.
- C. Install water testing equipment on wall near water chemical application equipment.
- D. Install interconnecting control wiring for chemical treatment controls and sensors.

- E. Bypass Feeders: Install in closed hydronic systems, including hot-water heating, 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 the feeder inlet.
  5. Install a swing check on the inlet after the isolation valve.

### 3.3 CONNECTIONS

- A. Where installing piping adjacent to equipment, allow space for service and maintenance.
- B. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Comply with requirements in Section "Hydronic Piping Specialties."
- C. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Section 230523 "General-Duty Valves for HVAC Piping."
- D. Confirm applicable electrical requirements in Division 26.
- E. Ground equipment according to Division 26.
- F. Connect wiring according to Division 26.

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
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 hydronic 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 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.
- C. Equipment will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. At four week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to "Performance Requirements" Article.
- F. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
  2. Acidity and Alkalinity: ASTM D 1067.
  3. Iron: ASTM D 1068.
  4. 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.
- B. Provide site inspection of equipment during scheduled shutdown to evaluate success of the treatment program. Make recommendations in writing based on these inspections.

**END OF SECTION 232513**

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## **SECTION 233113 - METAL DUCTS**

### **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 PERFORMANCE REQUIREMENTS**

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct 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"
  - 1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
  - 2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
  - 3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Indicated duct sizes are inside clear dimensions.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: None.

#### **1.4 QUALITY ASSURANCE**

- A. 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 D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
  - 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. Construct all ductwork to be free from vibration, chatter, objectionable pulsations and leakage under specified operating conditions. Objectionable conditions shall be corrected to the satisfaction of the Owner, at no cost to the Contract.

### **PART 2 - PRODUCTS**

#### **2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS**

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

## 2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
  - 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. Lindab Inc.
    - b. McGill AirFlow LLC.
    - c. SEMCO Incorporated.
    - d. Sheet Metal Connectors, Inc.
    - e. Spiral Manufacturing Co., Inc.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
  2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," 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's "HVAC Duct Construction Standards - Metal and Flexible."

### 2.3 SHEET METAL MATERIALS

- A. See drawing schedule for sheet metal material requirements.
- B. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- C. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G90.
  2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- D. Reinforcement Shapes and Plates: ASTM A 36/A 36M, 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.
- E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

### 2.4 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: 3 inches.
  3. Sealant: Modified styrene acrylic.
  4. Water resistant.
  5. Mold and mildew resistant.
  6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
  7. Service: Indoor and outdoor.

8. Service Temperature: Minus 40 to plus 200 deg F.
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).
11. 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."

C. Water-Based Joint and Seam Sealant:

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, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. 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).
7. 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."

E. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

F. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg 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.

## 2.5 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. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- 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.

## **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 according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. 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.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.
- M. Ductwork sleeves shall be formed with galvanized steel.
- N. Screws or duct penetrations shall not be permitted for FRP, PVC, Phenolic, or other ducts conveying dust, chemical, or fume exhausts.
- O. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- P. At ends of ducts not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering until time connections to be completed.
- Q. Sizing Variation: Round ducts may be installed in place of rectangular ducts and rectangular ducts may be installed in place of round ducts using equivalency tables from ASHRAE or SMACNA.
- R. Provide expanded take-offs for branch duct connections or 45 degree entry fittings. Square edge 90 degree take-off fittings or straight taps will not be accepted
- S. Size Change:
  - 1. Increase and decrease duct sizes gradually, not exceeding 20 degrees divergence and 30 degrees convergence from connecting upstream duct surface, unless otherwise noted on drawings.
  - 2. Maximum divergence upstream of equipment to be 20 degrees and maximum convergence downstream to be 30 degrees.
- T. Where ducts pass through interior partitions and exterior walls and are exposed to view, conceal spaces between construction openings and ducts or duct insulation with sheet metal flanges of same metal thickness as ducts. Overlap openings on 4 sides by at least 1-1/2 inches.
  - 1. Where ductwork passes through walls, floors, or ceilings of finished process rooms, provide stainless steel flange around penetration.
- U. Install duct to pitch as indicated on the drawings.

### 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. 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 or for slabs more than 4 inches thick.
  - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
  - 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16 feet.
- F. 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.

### 3.4 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.5 PAINTING

- A. Paint interior of metal ducts that are visible through 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 9.

### 3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
  - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
  - 2. Test the following systems:
    - a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
    - b. Supply Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
    - c. Return Ducts with a Pressure Class of 2-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
  - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
  - 4. Test for leaks before applying external insulation.
  - 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
  - 6. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
  - 1. Visually inspect duct system to ensure that no visible contaminants are present.
  - 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "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.



- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.7 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

### 3.8 DUCT SCHEDULE

- A. See drawing schedule for duct pressure, seal and leakage class, and elbow configuration.
- B. Fabricate ducts with galvanized sheet steel.
- C. Intermediate Reinforcement:
  - 1. Galvanized-Steel Ducts: Galvanized steel.
- D. Elbow Configuration:
  - 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
    - a. Velocity 1000 fpm 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:
      - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
    - c. Velocity 1500 fpm 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.
      - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
  - 2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."

- a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
  - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
  - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
- a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
    - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
    - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
    - 3) Velocity 1500 fpm 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 and Smaller in Diameter: Stamped or pleated.
  - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.
- E. Branch Configuration:
- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
    - a. Rectangular Main to Rectangular Branch: 45-degree entry.
    - b. Rectangular Main to Round Branch: Spin in.
  - 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
    - a. Velocity 1000 fpm or Lower: 90-degree tap.
    - b. Velocity 1000 to 1500 fpm: Conical tap.
    - c. Velocity 1500 fpm or Higher: 45-degree lateral.

**END OF SECTION 233113**

## **SECTION 233300 - AIR DUCT 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 ACTION SUBMITTALS**

- A. Product Data: None.

#### **1.3 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

### **PART 2 - PRODUCTS**

#### **2.1 ASSEMBLY DESCRIPTION**

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

#### **2.2 MATERIALS**

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90.
  - 2. Exposed-Surface Finish: Mill phosphatized.
- B. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- C. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

#### **2.3 MANUAL VOLUME DAMPERS**

- A. Standard, Steel, Manual Volume Dampers:

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. Air Balance Inc.; a division of Mestek, Inc.
    - b. American Warming and Ventilating; a division of Mestek, Inc.
    - c. Flexmaster U.S.A., Inc.
    - d. McGill AirFlow LLC.
    - e. Nailor Industries Inc.
    - f. Pottorff.
    - g. Ruskin Company.
    - h. Trox USA Inc.
    - i. Vent Products Company, Inc.
  2. Standard leakage rating, with linkage outside airstream.
  3. Suitable for horizontal or vertical applications.
  4. Frames:
    - a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
    - b. Mitered and welded corners.
    - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
  5. Blades:
    - a. Multiple or single blade.
    - b. Parallel- or opposed-blade design.
    - c. Stiffen damper blades for stability.
    - d. Galvanized-steel, 0.064 inch thick.
  6. Blade Axles: Galvanized steel.
  7. Bearings:
    - a. Molded synthetic.
    - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
  8. Tie Bars and Brackets: Galvanized steel.
- B. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
  2. Include center hole to suit damper operating-rod size.
  3. Include elevated platform for insulated duct mounting.

## 2.4 TURNING VANES

- 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. Ductmate Industries, Inc.
  2. Duro Dyne Inc.
  3. Elgen Manufacturing.
  4. METALAIRE, Inc.
  5. SEMCO Incorporated.
  6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- D. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

## 2.5 DUCT-MOUNTED ACCESS DOORS

- 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. American Warming and Ventilating; a division of Mestek, Inc.
  2. Cesco Products; a division of Mestek, Inc.
  3. Ductmate Industries, Inc.
  4. Elgen Manufacturing.
  5. Flexmaster U.S.A., Inc.
  6. Greenheck Fan Corporation.
  7. McGill AirFlow LLC.
  8. Nailor Industries Inc.
  9. Pottorff.
  10. Ventfabrics, Inc.
  11. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
1. Door:
    - a. Double wall, rectangular.
    - b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
    - c. Vision panel.
    - d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
    - e. Fabricate doors airtight and suitable for duct pressure class.
  2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
  3. Number of Hinges and Locks:

- a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
- b. Access Doors up to 18 Inches Square: Two hinges or Continuous and with two sash locks.

## 2.6 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. Ductmate Industries, Inc.
  2. Duro Dyne Inc.
  3. Elgen Manufacturing.
  4. Ventfabrics, Inc.
  5. Ward Industries, Inc.; a division 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 3-1/2 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
1. Minimum Weight: 26 oz./sq. yd.
  2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
  3. Service Temperature: Minus 40 to plus 200 deg F.

## 2.7 FLEXIBLE DUCTS

- 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. Flexmaster U.S.A., Inc.
  2. McGill AirFlow LLC.
  3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, meeting requirements of NFPA 90A with flame spread of 25 or less and smoke developed rating of 50 or under, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film with minimum perm rating of 0.05 perm.
1. Pressure Rating:
    - a. 10-inch wg positive for ducts 4"-12" ID.
  2. Maximum Air Velocity: 4000 fpm.

3. Temperature Range: Minus 20 to plus 175 deg F.
4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1 minimum 1" fiberglass insulation blanket with maximum thermal conductance of 0.23 K at 75°F.

C. Flexible Duct Connectors:

1. Clamps: Nylon strap in sizes 3 through 18 inches, to suit duct size.
2. Non-Clamp Connectors: Liquid adhesive plus tape.

D. Flexible Ductwork Elbow Supports:

1. Available Manufacturers:
  - a. Thermaflex: Flexflow Elbow
2. In lieu of using die stamped elbows for flexible duct connections to supply air diffusers (as detailed on the drawings), the Contractor may delete the die stamped elbow and directly connect the flexible duct to the diffusers with the use of a flexible ductwork elbow support.
3. Elbow supports shall be constructed of durable composite material and shall be fully adjustable to support flexible ductwork diameter from 6" to 16" in diameter.
4. Elbow supports shall be in UL listed for use in return air plenums.

## 2.8 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.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. 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.

- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Install test holes at fan inlets and outlets and elsewhere as indicated.
- F. 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. At drain pans and seals.
  - 3. Upstream from turning vanes.
  - 4. Control devices requiring inspection.
  - 5. Elsewhere as indicated.
- G. Install access doors with swing against duct static pressure.
- H. Access Door Sizes:
  - 1. One-Hand or Inspection Access: 12 by 12 inches.
  - 2. Two-Hand Access: 12 by 12 inches.
  - 3. Head and Hand Access: 18 by 12 inches.
- I. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- J. Install flexible connectors to connect ducts to equipment.
- K. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
- L. Connect diffusers or light troffer boots to ducts directly or with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- M. Install duct test holes where required for testing and balancing purposes.
- N. Access doors constructed with sheet metal screw fasteners will not be accepted
- O. Flexible Ductwork:
  - 1. Do not exceed 5 feet in length. Flexible ducts shall be used only to compensate for branch duct and diffuser/grille misalignment. No kinks or bends shall be allowed.
  - 2. Install flexible ductwork with minimum offsets, sag, and trim.
  - 3. Connect with adjustable band and clamp to secure duct to trunk fitting and to distribution unit fitting. Banding shall be nylon straps, fastened under insulation and over the inner lines with a second band securing the insulation and jacket. Sheet metal screws will not be accepted.
  - 4. Seal ends of flex duct with foil duct tape over insulation and jacket.
  - 5. Individual sections of flexible ductwork shall be of one piece construction. Splicing of short sections will not be accepted.
  - 6. Penetration of any partition, wall, or floor with flexible duct will not be accepted.
  - 7. Minimum length of duct trunk fitting for flex duct connection shall be 4 inches.



### 3.2    FIELD QUALITY CONTROL

#### A.    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.    Inspect turning vanes for proper and secure installation.

**END OF SECTION 233300**

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## **SECTION 233713 - DIFFUSERS, REGISTERS, AND 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 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated, include the following:
1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
  2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

### **PART 2 - PRODUCTS**

#### **2.1 CEILING LINEAR SLOT OUTLETS**

- A. Linear Bar Diffuser (LD-1):
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. Carnes.
    - b. Hart & Cooley Inc.
    - c. Krueger.
    - d. METALAIRE, Inc.
    - e. Nailor Industries Inc.
    - f. Price Industries.
    - g. Titus.
    - h. Tuttle & Bailey.
  2. Devices shall be specifically designed for variable-air-volume flows.
  3. Material: See Air Outlets and Inlets on schedule drawing..
  4. Finish: See Air Outlets and Inlets Schedule on drawings.
  5. Narrow Core Spacing Arrangement: 1/8-inch-thick blades spaced 1/4 inch apart, 15-degree deflection.
  6. One-Way Deflection Vanes: Extruded construction fixed louvers with removable core.
  7. Frame: 1-1/4 inches wide.
  8. Mounting: Concealed bracket.
  9. Damper Type: See Air Outlets and Inlets Schedule on drawings.

## 2.2 REGISTERS AND GRILLES

### A. Adjustable Bar Grille (SG-1):

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-J Manufacturing Co., Inc.
  - b. Carnes.
  - c. Hart & Cooley Inc.
  - d. Krueger.
  - e. METALAIRE, Inc.
  - f. Nailor Industries Inc.
  - g. Price Industries.
  - h. Titus.
  - i. Tuttle & Bailey.
2. Material: See Air Outlets and Inlets Schedule on drawings.
3. Finish: See Air Outlets and Inlets Schedule on drawings.
4. Frame: See Air Outlets and Inlets Schedule on drawings.
5. Mounting: See Air Outlets and Inlets Schedule on drawings.

### B. Fixed Face Grille (RG-1,2):

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-J Manufacturing Co., Inc.
  - b. Carnes.
  - c. Hart & Cooley Inc.
  - d. Krueger.
  - e. Nailor Industries Inc.
  - f. Price Industries.
  - g. Titus.
  - h. Tuttle & Bailey.
2. Material: See Air Outlets and Inlets Schedule on drawings.
3. Finish: See Air Outlets and Inlets Schedule on drawings.
4. Face Arrangement: See Air Outlets and Inlets Schedule on drawings.
5. Frame: See Air Outlets and Inlets Schedule on drawings wide.
6. Mounting: See Air Outlets and Inlets Schedule on drawings.

## 2.3 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. 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.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: 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.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

### **3.3 ADJUSTING**

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

**END OF SECTION 233713**

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## **SECTION 235216 – CONDENSING BOILERS**

### **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 ACTION SUBMITTALS**

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories. For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work
  - 1. Include diagrams for power, signal, and control wiring.
  - 2. Warranty: Special warranty specified in this Section.

#### **1.3 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

#### **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. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- E. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- F. Boiler shall be provided with fuel train and operating controls conforming to the latest CSD-1 requirements.
- G. Comply with State of Michigan boiler codes and regulations.
- H. All boiler equipment, trim, and accessories shall be shipped factory mounted, except for items removed due to shipping clearances. All items removed for shipping shall be noted.

## 1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

## 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.

- 1. Warranty Period for Pulse-Combustion Boilers:

- a. Heat Exchanger Damaged by Thermal Shock: 10 years from date of Substantial Completion.
- b. Heat-Exchanger Corrosion: Nonprorated for five years from date of Substantial Completion.

- 2. Warranty Period for Fire-Tube Condensing Boilers:

- a. Leakage and Materials: 10 years from date of Substantial Completion.
- b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for five years from date of Substantial Completion.

- 3. Warranty Period for Water-Tube Condensing Boilers: 20 years from date of Substantial Completion.

- 4. Warranty Period for Water-Jacketed Condensing Boilers:

- a. Leakage and Materials: Eight years from date of Substantial Completion.
- b. Heat Exchanger Damaged by Thermal Stress and Corrosion: Nonprorated for five years from date of Substantial Completion.

## 1.7 FIELD CONDITIONS

- A. Altitude above Mean Sea Level: 900 feet.

## **PART 2 - PRODUCTS**

### 2.1 FIRE-TUBE CONDENSING BOILERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. HTP.

- B. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.

- C. Heat Exchanger: Nonferrous, corrosion-resistant combustion chamber.



- D. Pressure Vessel: Carbon steel with welded heads and tube connections.
- E. Burner: Natural gas, forced draft.
- F. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
  - 1. Motors: Comply with requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    - a. 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.
- G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- H. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- I. Casing:
  - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
  - 2. Control Compartment Enclosures: NEMA 250, Type 1A.
  - 3. Finish: Baked-enamel protective finish.
  - 4. Insulation: Minimum 2-inch-thick, mineral-fiber insulation surrounding the heat exchanger.
  - 5. Combustion-Air Connections: Inlet and vent duct collars.
  - 6. Mounting base to secure boiler to wall.
- J. Capacity Control: Boiler firing rate control shall be the following as a minimum:
  - 1. Full modulation with a minimum 10:1 turndown ratio.

## 2.2 WATER-TUBE CONDENSING BOILERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Laars Heating Systems Company.
  - 2. Lochinvar Corporation.
- B. Description: Factory-fabricated, -assembled, and -tested, water-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.
- C. Heat Exchanger: Stainless-steel heat exchangers.
- D. Combustion Chamber: Stainless steel, sealed.
- E. Burner: Natural gas, forced draft drawing from gas premixing valve.

- F. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
  - 1. Motors: Comply with requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    - a. 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.
- G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- H. Ignition: Silicone carbide hot-surface ignition that includes flame safety supervision and 100 percent main-valve shutoff.
- I. Integral Circulator: Cast-iron body and stainless-steel impeller sized for minimum flow required in heat exchanger.
- J. Casing:
  - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
  - 2. Control Compartment Enclosures: NEMA 250, Type 1A.
  - 3. Finish: Textured epoxy.
  - 4. Insulation: Minimum 1-inch-thick, mineral-fiber insulation surrounding the heat exchanger.
  - 5. Combustion-Air Connections: Inlet and vent duct collars.
  - 6. Mounting base to secure boiler.
- K. Capacity Control: Boiler firing rate control shall be the following as a minimum:
  - 1. Full modulation with a minimum 5:1 turndown ratio.

### 2.3 TRIM

- A. Include devices sized to comply with ANSI B31.9, "Building Services Piping."
- B. Safety Relief Valve: ASME rated.
- C. Pressure and Temperature Gage: Minimum 3-1/2-inch-diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.
- D. Boiler Air Vent: Automatic.
- E. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
- F. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

## 2.4 CONTROLS

- A. Refer to Section 230900 "Instrumentation and Control for HVAC."
- B. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
  - 1. Hardwired Points:
    - a. Monitoring: On/off status, common trouble alarm.
    - b. Control: On/off operation, hot water supply temperature set-point adjustment.
  - 2. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

## 2.5 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
  - 1. House in NEMA 250, Type 1 enclosure.
  - 2. Wiring shall be numbered and color-coded to match wiring diagram.
  - 3. Field power interface shall be to fused disconnect switch.
  - 4. Provide branch power circuit to each motor and to controls with a disconnect switch or circuit breaker capable of being locked in the open position at an accessible location at the boiler; integral or adjacent to the boiler.
  - 5. Provide each motor with overcurrent protection.
  - 6. Provide a manually operated remote emergency shutdown switch or circuit breaker just inside the boiler room door and mark for easy identification.

## 2.6 VENTING KITS

- A. Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and dilution tank, and sealant.
- B. Combustion-Air Intake: Complete system, stainless steel, pipe, vent terminal with screen, inlet air coupling, and sealant. Concentric venting not allowed.
  - 1. Optional: Intake piping material may be schedule 40 PVC in lieu of stainless steel.
- C. Verify air pipe sizes shown on drawings with boiler manufacturer to ensure pipe is large enough to accommodate length of pipe and number of fittings in system.

## 2.7 BOILER MANAGEMENT SYSTEM (BMS)

- A. Manufacturers: Honeywell, Heat Timer, Tekmar, or equal.
- B. Provide a multiple boiler sequencing panel capable of staging multiple boilers to maintain peak seasonal efficiency.
- C. The BMS shall include:
  - 1. Main loop temperature sensor monitor.
  - 2. Outside air temperature monitor.
- D. BMS shall be capable of:
  - 1. Outdoor air temperature reset of supply water temperature.
  - 2. Loop temperature span.
  - 3. Loop temperature setpoint.
  - 4. Staging boilers based on loop temperature and outdoor reset for highest operating seasonal efficiencies.
  - 5. Starting and stopping the system based on a remote contact closure.
  - 6. Changing setpoint from a remote location.

## 2.8 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- C. Allow Owner access to source quality-control testing of boilers. Notify Architect 14 days in advance of testing.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
  - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 BOILER INSTALLATION

- A. Equipment Mounting:
  - 1. Install floor mounted boilers on existing cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 03.
  - 2. Install wall mounted boilers per manufacturer's recommendations.
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.
- F. Flush, cure, and thoroughly clean boilers and boiler accessories upon completion of installation and prior to start-up in accordance with boiler manufacturer's instruction.

### 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 boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 232116 "Hydronic Piping Specialties."
- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.
- G. Install piping from safety relief valves to nearest floor drain.
- H. Boiler Venting:
  - 1. Install flue venting kit and combustion-air intake.
  - 2. Connect full size to boiler connections.
- I. Ground equipment according to Division 26.
- J. Connect wiring according to Division 26.

K. All gas train items requiring venting shall be vented to outdoors.

### 3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Perform installation and startup checks according to manufacturer's written instructions.
2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
  - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Remove and replace malfunctioning units and retest as specified above.

### 3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Division 01.

**END OF SECTION 235216**

## **SECTION 238126 - SPLIT-SYSTEM AIR-CONDITIONERS**

### **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 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- C. Wiring Diagrams: For power, signal, and control wiring.

#### **1.3 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

#### **1.4 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 Compliance:
  - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
  - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

#### **1.5 COORDINATION**

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03.
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.
2. Coleman Company Inc. (The).
3. First Operations LP.
4. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
5. SANYO North America Corporation; SANYO Fisher Company.

### **2.2 INDOOR UNITS (5 TONS OR LESS)**

A. Ducted, Evaporator-Fan Components:

1. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
2. Fan: Direct drive, centrifugal.
3. Fan Motors:
  - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in "Common Motor Requirements for HVAC Equipment."
  - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
  - c. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
  - d. Mount unit-mounted disconnect switches on exterior of unit.
4. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
5. Condensate Drain Pans:
  - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
    - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.

6. Filters: Cleanable

### **2.3 OUTDOOR UNITS (5 TONS OR LESS)**

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and



- mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
    - a. Compressor Type: Scroll.
    - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
    - c. Refrigerant Charge: R-407C or R-410A.
    - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
  3. Fan: Aluminum-propeller type, directly connected to motor.
  4. Motor: Permanently lubricated, with integral thermal-overload protection.
  5. Refrigeration Components:
    - a. Refrigerant circuit components shall include brass external liquid line service valve with service gage port connections, suction line service valve with service gage connection port, service gage port connections on compressor suction and discharge lines, accumulator, pressure relief, and a full charge of refrigerant.
  6. Controls and Safeties:
    - a. Operating controls and safeties shall be factory selected, assembled, and tested. The minimum control functions shall include the following:
      - 1) Controls:
      - 2) Time delay restart to prevent compressor reverse rotation on single-phase scroll compressors.
      - 3) Automatic restart on power failure.
      - 4) Safety lockout if any outdoor unit safety is open.
      - 5) A time delay control sequence provided through the fan coil board, thermostat, or controller.
      - 6) Automatic outdoor-fan motor protection.
    - b. Safeties:
      - 1) System diagnostics.
      - 2) Compressor motor current and temperature overload protection.
      - 3) High pressure relief.
      - 4) Outdoor fan failure protection.
  7. Electrical Requirements:
    - a. Unit electrical power shall be a single point connection.
    - b. Unit control voltage to the indoor-fan coil shall be 24 V.
    - c. All power and control wiring must be installed per NEC and all local building codes.

- 1) High- and low-voltage terminal block connections.
- d. Accessories:
- 1) Low-Ambient Operation:
    - a) The control shall be capable of enabling unit operation and start-up with outdoor temperatures to -20°F.
    - b) Installation of kit shall not require changing the outdoor-fan motor.

## 2.4 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC."
- B. Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- C. Automatic-reset timer to prevent rapid cycling of compressor.
- D. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
  1. Minimum Insulation Thickness: 1 inch thick.
- E. Unit shall be furnished with integral hanging hardware.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Equipment Mounting:
  1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Division 03.
- D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

### 3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Ground equipment according to Division 26.
- D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

### 3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- 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, start units to confirm proper motor rotation and unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

### 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.
- B. Deliver unit wireless infrared remote controller to Owner with complete set of new batteries.

### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

**END OF SECTION 238126**

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## **SECTION 238239.16 - PROPELLER UNIT HEATERS**

### **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 DEFINITIONS**

- A. BAS: Building automation system.
- B. CWP: Cold working pressure.
- C. PTFE: Polytetrafluoroethylene plastic.
- D. TFE: Tetrafluoroethylene plastic.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

#### **1.4 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. 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. Modine.
  - 2. Reznor.
  - 3. Sterling.

#### **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 wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig 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. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

### 2.7 CONTROLS

- A. Control Devices:
  - 1. Existing wall-mounted thermostat. Unit to operate in conjunction with VAV box located in room upon a call for heating.

## **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 elastomeric hangers. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- D. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
- E. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
- F. Clean dust and debris from each unit as it is installed. Comb out damaged fins where bent or crushed before covering elements with enclosures.

### **3.3 CONNECTIONS**

- A. Piping installation requirements are specified in Section 232113 "Hydronic Piping," Section 232116 Hydronic Piping Specialties." 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 steam-supply connection and union, strainer, and gate or ball valve on condensate-return connection of propeller unit heater.
- F. Ground equipment according to Division 26. 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. 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.

**3.5 ADJUSTING**

- A. Adjust initial temperature set points.

**3.6 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

**END OF SECTION 238239.16**



## **SECTION 238316 - RADIANT-HEATING 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 radiant-heating piping, including pipes, fittings, and piping specialties.

#### **1.3 DEFINITIONS**

- A. CWP: Cold working pressure.
- B. PEX: Crosslinked polyethylene.
- C. PEX/AL/PEX: Crosslinked polyethylene/aluminum/crosslinked polyethylene.
- D. PTFE: Polytetrafluoroethylene plastic.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include data for piping, fittings, manifolds, specialties, and controls; include pressure and temperature ratings, oxygen-barrier performance, fire-performance characteristics, and water-flow and pressure-drop characteristics.
  - 2. Provide product data for injection pumps and control valves.
- B. Shop Drawings: Show piping layout and details drawn to scale, including valves, manifolds, controls, and support assemblies, and their attachments to building structure.
  - 1. Shop Drawing Scale: 1/4 inch = 1 foot.
  - 2. Drawing(s) shall show proof of review and approval by radiant floor heating system manufacturer.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For radiant-heating piping valves and equipment to include in operation and maintenance manuals.

#### **1.6 WARRANTY**

- A. Manufacturer's standard twenty (20) year warranty on tubing.
- B. Manufacturer's standard thirty-six (36) month warranty on manifolds and other auxiliary components.

## **PART 2 - PRODUCTS**

### **2.1 PEX PIPE AND FITTINGS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. FloorHeat Company (The).
  2. Heat Innovations Inc.
  3. HeatLink Group Inc.
  4. Infloor Radiant Floor Heating.
  5. IPEX Inc.
  6. Mr Pex Systems Inc.
  7. REHAU Incorporated.
  8. Slant/Fin Corporation.
  9. Uponor.
  10. Viega.
  11. Warmboard Inc.
  12. Watts Radiant, inc.; a Watts Water Technologies company.
  13. Zurn Industries, LLC; Zurn Pex, Inc.
- B. Pipe Material: PEX plastic according to ASTM F 876.
- C. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.
- D. Fittings: ASTM F 1807, metal insert and copper crimp rings.
- E. Pressure/Temperature Rating: Minimum 100 psig and 180 deg F.

### **2.2 PEX/AL/PEX PIPE AND FITTINGS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Heat Innovations Inc.
  2. IPEX Inc.
  3. Uponor.
  4. Viega.
- B. Pipe Material: PEX plastic bonded to the inside and outside of a welded aluminum tube according to ASTM F 1281.
- C. Oxygen Barrier: Limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.
- D. Fittings: ASTM F 1974, metal insert fittings with split ring and compression nut (compression joint) or metal insert fittings with copper crimp rings (crimp joint).
- E. Flame-Spread and Smoke-Developed Indices: 25 and 50 or less, respectively, tested according to ASTM E 84.

F. Pressure/Temperature Rating: Minimum 100 psig and 210 deg F.

### 2.3 EPDM PIPE AND FITTINGS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Watts Radiant, Inc.; a Watts Water Technologies company.

B. Pipe Material: Crosslinked EPDM inner and outer tubes.

C. Wall Thickness: Minimum 0.125 inch.

D. Oxygen Barrier: Ductile aluminum foil layer applied to the inner tube to limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.

E. Reinforcing Braid: Braided-aluminum wire between the inner and outer tube.

F. Fittings: ASTM F 1807, copper with stainless-steel crimps or clamps.

G. Pressure/Temperature Rating: Minimum 100 psig and 210 deg F.

### 2.4 DISTRIBUTION MANIFOLDS

A. Manifold: Minimum NPS 1, brass copper or stainless steel.

B. Main Shutoff Valves:

1. Factory installed on supply and return connections.

2. Two-piece body.

3. Body: Brass or bronze.

4. Ball: Chrome-plated bronze.

5. Seals: PTFE.

6. CWP Rating: 150 psig.

7. Maximum Operating Temperature: 225 deg F.

C. Manual Air Vents:

1. Body: Bronze.

2. Internal Parts: Nonferrous.

3. Operator: Key furnished with valve, or screwdriver bit.

4. Inlet Connection: NPS 1/2.

5. Discharge Connection: NPS 1/8.

6. CWP Rating: 150 psig.

7. Maximum Operating Temperature: 225 deg F.

D. Balancing Valves:

1. Body: Plastic or bronze, ball or plug, or globe cartridge type.

2. Ball or Plug: Brass or stainless steel.

3. Globe Cartridge and Washer: Brass with EPDM composition washer.

4. Seat: PTFE.
5. Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.
6. Differential Pressure Gage Connections: Integral seals for portable meter to measure loss across calibrated orifice.
7. Handle Style: Lever or knob, with memory stop to retain set position if used for shutoff.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

E. Thermometers:

1. Mount on supply and return connections.
2. Case: Dry type, metal or plastic, 2-inch diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, connecting element and pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Black metal.
7. Window: Plastic.
8. Connector: Rigid, back type.
9. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem.
10. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

F. Mounting Brackets: Copper, or copper-clad steel, where in contact with manifold.

## 2.5 PIPING SPECIALTIES

A. Cable Ties:

1. Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
2. Minimum Width: 1/8 inch.
3. Tensile Strength: 20 lb, minimum.
4. Temperature Range: Minus 40 to plus 185 deg F.

## 2.6 CONTROLS

A. Temperature-control devices and sequence of operations are specified in Section 230900 "Instrumentation and Control for HVAC."

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Danfoss Inc.
2. HeatLink Group Inc.
3. Honeywell International Inc.
4. Infloor Radiant Floor Heating.
5. IPEX Inc.

6. REHAU Incorporated.
7. Slant/Fin Corporation.
8. tekmar Control Systems, Ltd.
9. Uponor.
10. Viega.
11. Watts Radiant, inc.; a Watts Water Technologies company.
12. Zurn Industries, LLC; Zurn Pex, Inc.

C. Precipitation and Temperature Sensor:

1. Microprocessor-based control with manual on, automatic, and standby/reset switch.
2. Precipitation and temperature sensors shall sense the surface conditions of pavement and shall be programmed to operate pump and zone control valves as follows:
  - a. Temperature Span: 34 to 44 deg F.
  - b. Adjustable Delay Off Span: 30 to 90 minutes.
  - c. Start Pump or Open Zone Control Valves: Following two-minute delay if ambient temperature is below set point and precipitation is detected.
  - d. Stop Pump or Close Zone Control Valves: On detection of a dry surface plus time delay.
3. Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.
4. Minimum 30-A contactor to start pump and open valves.
5. Precipitation sensor shall be mounted in pavement.
6. Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

D. Slab temperature sensor

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine surfaces and substrates to receive radiant-heating piping for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  1. Ensure that surfaces and pipes in contact with radiant-heating piping are free of burrs and sharp protrusions.
  2. Ensure that surfaces and substrates are level and plumb.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 APPLICATIONS**

- A. Install the following types of radiant-heating piping for the applications described:

1. Piping in Exterior Pavement: EPDM, PEX, or PEX/AL/PEX.

### 3.3 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 Shop Drawings or coordination drawings.
- B. Install radiant-heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.
  1. If a fitting must be installed in the concrete slab it must be protected with a HDPE shrink sleeve as recommended by the manufacturer and must be approved by the engineer.
- C. Connect radiant piping to manifold in a reverse-return arrangement.
- D. Do not bend pipes in radii smaller than manufacturer's minimum bend radius dimensions.
- E. Install manifolds in accessible locations or install access panels to provide maintenance access as required.
- F. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties" for pipes and connections to hydronic systems and for glycol-solution fill requirements.
- G. Piping in Exterior Pavement:
  1. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
  2. Space cable ties a maximum of 18 inches o.c. and at center of turns or bends.
  3. Maintain 3-inch minimum cover.
  4. Install a sleeve of 3/8-inch-thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
  5. Maintain minimum 40-psig pressure in piping during concrete placement and continue for 24 hours after placement.
- H. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Architect.
- I. After system balancing has been completed, mark balancing valves to permanently indicate final position.
- J. Perform the following adjustments before operating the system:
  1. Open valves to fully open position.

2. Check operation of automatic valves.
  3. Set temperature controls so all zones call for full flow.
  4. Purge air from piping.
- K. After concrete or plaster heating panel has cured as recommended by concrete or plaster supplier, operate radiant-heating system as follows:
1. Start system heating at a maximum of 10 deg F above the ambient radiant-panel temperature and increase 10 deg F each following day until design temperature is achieved.
  2. For freeze protection, operate at a minimum of 60 deg F supply-water temperature.
- L. Maximum loop lengths shall be:
1. 3/8" diameter tubing: 200 ft.
  2. 1/2" diameter tubing: 300 ft.
  3. 5/8" diameter tubing: 500 ft.
  4. 3/4" diameter tubing: 500 ft.
- M. Tubing connections shall be made with compression fittings supplied by manufacturer. Fittings from other sources are not acceptable.
- N. Extend power wiring from fused disconnect to electrical junction box on unit.
1. Install thermostat or sensor in indicated location, provide line or low voltage wiring from thermostat to electrical junction box on unit.
  2. Comply with Division 26 specifications for wiring.
- O. All fittings shall be accessible for maintenance.
- P. When installing the tubing the joint must be made immediately or capped with tape to seal the tube from contaminants.
- Q. All circuits will be labeled and marked as supply and return. The contractor will submit a record of actual tube circuit length for final balancing purposes.

### 3.4 FIELD QUALITY CONTROL

- A. Prepare radiant-heating piping for testing as follows:
1. Open all isolation valves and close bypass valves.
  2. Open and verify operation of zone control valves.
  3. Flush with clean water and clean strainers.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
1. Leak Test: After installation, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Radiant-heating piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Protect hydronic piping system from damage during construction.

**END OF SECTION 238316**



## **SECTION 260500 - 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 all Sections of divisions 26.

#### **1.2 DESCRIPTION**

- A. Work to be performed under the sections of Divisions 26 includes all labor, materials, and equipment required to install complete electrical systems as described in these specifications and as shown on the drawings. This section includes information common to two or more technical specification sections or items that are of a general nature, not conveniently fitting into other technical sections.
- B. Before submitting a bid, the Contractor shall examine the drawings and specifications, visit the work site, and be informed of local conditions, all federal, state and local ordinances, regulations and all other pertinent items which may affect cost, schedule, and completion of this project.
- C. Drawings accompanying these specifications are a part of these specifications. Drawings are intended to show general arrangement, design, and extent of work and are diagrammatic. Drawings are not intended to show exact locations except where dimensions are shown. Any substantial differences existing between drawings and conditions in the field shall be submitted to the Owner for consideration before proceeding with work. Electrical work is shown on plans using standard industry symbols.
- D. Before ordering materials or doing work, the Contractor shall verify all measurements pertaining to work scope and assume installation responsibility for complete and fully functional electrical systems.
- E. The electrical work included in all other divisions of this specification and related documents is the responsibility of the contractor performing the Division 26, work unless specifically noted otherwise.

#### **1.3 REFERENCED STANDARDS**

- A. Abbreviations of standards organizations referenced in this and other sections are as follows:

ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
EPA	Environmental Protection Agency
ETL	Electrical Testing Laboratories, Inc.
IBC	International Building Code

IEEE	Institute of Electrical and Electronics Engineers
IES	Illuminating Engineering Society
ISA	Instrument Society of America
NBS	National Bureau of Standards
NEC	National Electric Code
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
UL	Underwriters Laboratories Inc.

#### 1.4 QUALITY ASSURANCE

- A. Manufacturer references used herein are intended to establish a level of quality and performance requirements unless more explicit restrictions are stated to apply.
- B. Where equipment or accessories are used which differ in arrangement, configuration, dimensions, ratings, or engineering parameters from those indicated on the contract documents, the contractor is responsible for all costs involved in integrating the equipment or accessories into the system and the assigned space and for obtaining the performance from the system into which these items are placed.
- C. All materials, shall be listed by and shall bear the label of an approved electrical testing laboratory. If none of the approved electrical testing laboratories has published standards for a particular item, then other national independent testing standards, subject to approval by the Owner, shall apply and such items shall bear those labels. Where one of the approved electrical testing laboratories has an applicable system listing and label, the entire system shall be so labeled. The Contractor shall not modify new equipment in such a way as to nullify the Testing Laboratories label. All equipment and materials shall be used or installed in accordance with any instruction included in the listing by the laboratory.

#### 1.5 DEFINITIONS

Activation: Nomenclature used by some manufacturers for a service fitting.

ATS: Acceptance Testing Specifications.

BACnet: A networking communication protocol that complies with ASHRAE 135.

BAS: Building automation system.

BF: Ballast factor.

CCT: Correlated color temperature.

CE: Conformance Europeene (European Compliance).

CEC: California Energy Commission.

CPT: Control power transformer.

CRI: Color-rendering index.

DALI: Digital addressable lighting interface; complies with IEC 60929, Annexes E and G.

Data Bus: Two wires used to communicate with bus connected devices.

Delegated-Design Submittals: Documents, including drawings, calculations, and material and product specifications prepared as a responsibility of Contractor to obtain acceptance by Owner and authorities having jurisdiction.

Direct Buried: Duct or a duct bank that is buried in the ground, without an additional casing materials such as concrete.

Device: A collective term for DALI-compliant bus connected devices, including fluorescent ballasts, incandescent fixtures, manual switches, switching relays, and similar. Sometimes also known as "slave unit."

Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.

EMT: Electrical metallic tubing.

Ethernet: Local area network based on IEEE 802.3 standards.

Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.

Firmware: Software (programs or data) that has been written onto read-only memory (ROM). Firmware is a combination of software and hardware. Storage media with ROMs that have data or programs recorded on them are firmware.

FMG: Factory Mutual Group

GFCI: Ground-Fault Circuit Interrupter.

GRC: Galvanized rigid steel conduit.

Group: A set of devices that respond at the same time to messages on the data bus.

HID: High-intensity discharge.

HPS: High-pressure sodium.

HTML: Hypertext markup language.

IBC: International Building Code.

ICC-ES: ICC-Evaluation Service.

IGBT: Insulated-gate bipolar transistor.

Illuminance: The metric most commonly used to evaluate lighting systems. It is the density of luminous flux, or flow of light, reaching a surface divided by the area of that surface.

1. Horizontal Illuminance: Measurement in foot-candles (lux), on a horizontal surface 36 inches above ground unless otherwise indicated.
2. Target Illuminance: Average maintained illuminance level, calculated by multiplying initial illuminance by LLF.
3. Vertical Illuminance: Measurement in foot-candles (lux), in four directions on a vertical surface, at an elevation coinciding with plane height of horizontal measurements.

IMC: Intermediate metal conduit.

I/O: Input/output.

IP: Internet protocol.

IP Code: Required ingress protection to comply with IEC 60529.

IR: Infrared.

Jacket: A continuous nonmetallic outer covering for conductors or cables.

LAN: Local area network; sometimes plural as "LANs."

LC: Lighting Certified.

LCD: Liquid crystal display.

LED: Light-emitting diode.

Legally Required: As used in this Section, it shall have the same meaning as used in NFPA 70.

LER: Luminaire efficacy rating.

Light Trespass: Light spill into areas and properties outside the playing areas, which is either annoying or unwanted.

LLD: Lamp lumen depreciation, which is the decrease in lamp output as the lamp ages.

LLF: Light loss factor, which is the product of all factors that contribute to light loss in the system.

LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or remote-control, signaling and power-limited circuits.

Lumen: Measured output of lamp and luminaire, or both.

Luminaire: Complete lighting fixture, including ballast housing if integral.

MCC: Motor-control center.

MCCB: Molded-case circuit breaker.

Modbus TCP/IP: An open protocol for exchange of process data.

Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

Monitoring: Acquisition, processing, communication, and display of equipment status data, metered electrical parameter values, power quality evaluation data, event and alarm signals, tabulated reports, and event logs.

NC: Normally closed.

NETA ATS: Acceptance Testing Specification.

NiCd: Nickel cadmium.

NO: Normally open.

OCPD: Overcurrent protective device.

One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.

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.

OSHPD: Office of Statewide Health Planning and Development for the State of California.

PC: Personal computer; sometimes plural as "PCs."

PCC: Point of common coupling.

PID: Control action, proportional plus integral plus derivative.

Pigtail: Short lead used to connect a device to a branch-circuit conductor.

Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for

transporting air to or from heating, ventilating, or air-conditioning equipment.

Pole: Luminaire support structure, including tower used for large area illumination.

Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.

PT: Potential transformer.

PTC: USA standard conditions for PV.

RFI: Radio-frequency interference.

RMC: Rigid metal conduit.

SCR: Silicon-controlled rectifier.

SCCR: Short-circuit current rating.

Sheath: A continuous metallic covering for conductors or cables.

SPD: Surge protective device.

SPDT: Single pole, double throw.

Standard: Same definition as "Pole" above.

STC: Standard Test Conditions defined in IEC 61215.

SVR: Suppressed voltage rating.

Traffic ways: Locations where vehicular or pedestrian traffic is a normal course of events.

TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.

TDD: Total demand (harmonic current) distortion (also listed as "THD" in catalog data by manufacturers).

THD: Total harmonic distortion.

THD(V): Total harmonic voltage demand.

Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

TVSS: Transient voltage surge suppressor.

UG: Uniformity gradient; the rate of change of illuminance on the playing field, expressed as a ratio between the illuminances of adjacent measuring points on a uniform grid.

UTP: Unshielded twisted pair.

VFD – Variable frequency drive or motor controller.

VPN: Virtual private network.

VPR: Voltage protection rating.

Zone: A fixture or group of fixtures controlled simultaneously as a single entity. Also known as a "channel."

## 1.6 REGULATORY REQUIREMENTS

- A. All work and materials are to conform in every detail to applicable rules and requirements of local codes and regulations, the National Electrical Code (NFPA 70), other applicable National Fire Protection Association codes, and current manufacturing standards (including NEMA) and any additional local modifications enacted by the Local Authority Having Jurisdiction. Contractor shall be responsible to verify what if any local modifications are in place or enacted by the Local Authority Having Jurisdiction.
- B. All work shall be installed in accordance with NECA standards of installation.
- C. All work shall conform where applicable to the Williams-Steiger Occupational Safety and Health Act of 1970 (OSHA), Part 1910, "Occupational Safety and Health Standards." This shall include any local or state modifications enacted by the Authority having Jurisdiction.

## 1.7 OMISSIONS

- A. No later than ten (10) days before bid opening , the Contractor shall call to the attention of the Owner any materials or apparatus the Contractor believes to be inadequate and to any necessary items of work omitted.

## 1.8 SUBMITTALS

- A. Refer to Division 01 for Submittal requirements.
- B. Submit for all equipment and systems as indicated in the respective specification sections, marking each submittal with that specification section number. Mark general catalog sheets and drawings to indicate specific items being submitted and proper identification of equipment by name or number, as indicated in the contract documents. Failure to do this may result in the submittal(s) being returned to the Contractor for correction and resubmission. Failing to follow these instructions does not relieve the Contractor from the requirement of meeting the project schedule.
- C. On request, the Contractor shall furnish additional drawings, illustrations, catalog data, performance characteristics, etc. to clarify intent of construction or operations.
- D. Submittals shall be in PDF format and searchable. Scanned catalog pages will not be acceptable. Submittals shall be grouped to include complete submittals of related systems, products, and accessories in a single submittal. Mark dimensions and values in

units to match those specified. Include wiring diagrams of electrically powered equipment.

- E. The submittals must be approved before fabrication.

#### 1.9 PROJECT/SITE CONDITIONS

- A. Install Work in locations shown on Drawings, unless prevented by Project conditions.
- B. Prepare drawings showing proposed rearrangement of work to meet Project conditions, including changes to work specified in other Sections. Obtain written permission of Owner before proceeding.
- C. Tools, materials, and equipment shall be confined to areas designated by the Owner.

#### 1.10 WORK SEQUENCE AND SCHEDULING

- A. See the General Conditions of the Contract, Scheduling and Coordination of Work, and Time for Completion of the Project, and General Requirements, Mutual Responsibility for additional requirements.

#### 1.11 WORK BY OTHER TRADES

- A. Every attempt has been made to indicate in this trade's specifications and drawings all work required of this Contractor. However, there may be additional specific paragraphs in other trade specifications and addenda, and additional notes on drawings for other trades which pertain to this Trade's work, and thus those additional requirements are hereby made a part of these specifications and drawings.
- B. Electrical details on drawings for equipment to be provided by others is based on preliminary design data only. This Contractor shall lay out the electrical work and shall be responsible for its correctness to match equipment actually provided by others.

#### 1.12 OPERATING AND MAINTENANCE INSTRUCTIONS

- A. Refer to Division 1, General Requirements, Operating and Maintenance Instructions for additional requirements.

#### 1.13 TRAINING

- A. Instruct Owner's personnel in the proper operation and maintenance of systems and equipment provided as part of this project; video record all training sessions. Use the Operating and Maintenance manuals during this instruction. Demonstrate startup and shutdown procedures for all equipment. All training to be during normal working hours.
- B. The requirement for recording training sessions may be deleted on some projects but not the requirement for the training itself.
- C. Refer to other sections in Divisions 26 for specific section and equipment training requirements.



## 1.14 RECORD DRAWINGS

- A. A set of prints shall be kept at the job site upon which all changes and deviations from the original design are to be recorded daily. All changes shall be clearly marked. These drawings shall indicate as a minimum, all changes made to the drawings, changes in circuiting, equipment location, accurate locations of embedded conduit, and all other significant changes and deviations from the original design.
- B. The daily record of changes shall be the responsibility of the Contractor's field representative. No arbitrary mark-ups will be permitted.
- C. The record drawing set shall be made available and may be audited periodically by the Owner to assure the changes are being recorded.
- D. At the completion of the project, the Contractor shall submit the marked-up record drawings to the Owner prior to request for final payment.

## **PART 2 - PRODUCTS**

### 2.1 MANUFACTURERS

- A. Reference applicable sections within Divisions 26.

## **PART 3 - EXECUTION**

### 3.1 WORK INCLUDED

- A. The scope of work shall include all work, including all labor, materials and equipment, testing required to install a complete electrical system as indicated in the project Manual. The Project Manual consists of the bidding documents, the contract, specifications, contract drawings and all subsequent addenda and modifications. The contractor shall furnish and install all necessary materials, apparatus and devices to complete the electrical equipment and systems installation herein specified, except such parts as are specifically exempted herein.
- B. All work items shown on the drawings is within the scope of work and shall be provided as indicated. Only items that are clearly indicated as being provided by others or under a separate contract shall be out of scope.
- C. In general, the specifications indicate the requirements and quality for products required and the executions for those products. Only items that are clearly indicated as being provided by others or under a separate contract shall be out of scope.
- D. If there is any discrepancy between the drawings and the specifications, it is the contractor's responsibility to notify the Owner for resolution, prior to procuring equipment or starting work. For bidding purposes, the item of higher quality and/or cost shall be assumed for any discrepancy found.

- E. Coordinate and verify all equipment being supplied by equipment supplier and other trades. Verify equipment size, motor HP, dimensions, locations, etc. as all are subject to change.
- F. Contractor shall verify all door swings and the location of all cabinets, diffusers, HVAC, plumping, process and building equipment before installing electrical equipment, fixtures, outlets and conduit.
- G. All permits and inspection fees required to complete the work shall be paid for by the Contractor unless noted otherwise.
- H. All electrical equipment and fixtures shall be installed in complete accordance with the manufacturers' recommendations.
- I. Contractor shall provide all motor connections as shown on the drawings and as specified herein.

### 3.2 SITE WORK

- A. The Contractor shall provide excavation and backfill for all electrical underground as required.

### 3.3 PERMITS, FEES, TAXES, INSPECTIONS

- A. Procure all applicable permits and licenses.
- B. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
- C. ELECTRICAL CONTRACTOR to pay all charges for permits or licenses.
- D. Pay all fees and taxes imposed by State, Municipal, and other regulatory bodies.
- E. Pay all charges arising out of required inspections by an authorized body.
- F. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
- G. Where applicable, all fixtures, equipment and materials shall be listed by Underwriter's Laboratories, Inc. or a nationally recognized testing organization.

### 3.4 BUILDING ACCESS

- A. Arrange for the necessary openings in the building to allow for admittance of all apparatus. When the building access was not previously arranged and must be provided by this contractor, restore any opening to its original condition after the apparatus has been brought into the building.

### 3.5 EQUIPMENT ACCESS

- A. Install all piping, conduit, ductwork, and accessories to permit access to equipment for maintenance. Coordinate the exact location of wall and ceiling access panels and doors with the General Contractor, making sure that access is available for all equipment and specialties. Where access is required in plaster or drywall walls or ceilings, furnish the access doors to the General Contractor and reimburse the General Contractor for installation of those access doors.

### 3.6 COORDINATION

- A. The Contractor shall cooperate with other trades and the Owner's construction representative in locating work in a proper manner. Should it be necessary to raise or lower or move longitudinally any part of the electrical work to better fit the general installation, such work shall be done at no extra cost, provided such decision is reached prior to actual installation. The Contractor shall check location of electrical outlets with respect to other installations before installing.
- B. The Contractor shall verify that all devices are compatible for the surfaces on which they will be used. This includes, but is not limited to, light fixtures, panelboards, devices, etc. and recessed or semi-recessed heating units installed in/on architectural surfaces.
- C. Coordinate all work with other trades prior to installation. Any installed work that is not coordinated and that interferes with another trades work shall be removed or relocated at the installing contractor's expense.

### 3.7 HOUSEKEEPING AND CLEAN UP

- A. The Contractor shall clean up and remove from the premises, on a daily basis, all debris and rubbish resulting from its work and shall repair all damage to new and existing equipment resulting from its work. When job is complete, the Contractor shall remove all tools, excess material and equipment, etc., from the site.

**END OF SECTION 260500**

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## **SECTION 260502 - ELECTRICAL DEMOLITION AND ALTERATION**

### **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. Section 260500 – Common Work Results for Electrical
- C. NFPA 70 – National Electrical Code

#### **1.2 COORDINATION**

- A. Coordinate sequencing with Owner and other Contractors. Coordinate scope of work with all other Contractors and the Owner at the project site. Schedule removal of equipment and electrical service to avoid conflicts.

#### **1.3 SUMMARY**

- A. Electrical Demolition
- B. The drawings are intended to indicate the scope of work required and do not indicate every box, conduit, or wire that must be removed. The Contractor shall visit the site prior to submitting a bid and verify existing conditions.

#### **1.4 CONTINUITY OF EXISTING SERVICES AND SYSTEMS**

- A. No outages shall be permitted on existing systems except at the time and during the interval specified by the Owner. The Owner may require written approval. Any outage must be scheduled when the interruption causes the least interference with normal Owner schedules and business routines. No extra costs will be paid to the Contractor for such outages which must occur outside of regular weekly working hours.
- B. This Contractor shall restore any circuit interrupted as a result of this work to proper operation as soon as possible.
- C. Prior to demolition, the following shall be accomplished:
  - 1. Disconnection of electrical power to utilization equipment and circuits removed or affected by demolition work.
  - 2. Electrical services rerouted or shut off outside area of demolition.
  - 3. Survey and record condition of existing facilities to remain in place that may be affected by demolition operations. After demolition operations are completed, survey conditions again and restores existing facilities to their pre-demolition condition.
  - 4. Contractor shall notify Architect/Engineer of existing code violations observed during the course of performing his work. If corrective action needs to be taken that changes the scope of the work, corrective action to proceed only after approved by Architect/Engineer.

5. All equipment and systems must remain operational unless specifically noted otherwise on drawings.

## **PART 2 - PRODUCTS**

### **2.1 MATERIALS AND EQUIPMENT**

- A. Materials and equipment for patching and extending work as specified in the individual Sections.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that abandoned wiring and equipment serve only abandoned equipment or facilities. Extend conduit and wire to facilities and equipment that will remain in operation following demolition. Extension of conduit and wire to equipment shall be compatible with the surrounding area.

### **3.2 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK**

- A. Repair adjacent construction and finishes damaged during demolition and extension work. Patch openings to match existing surrounding finishes.
- B. Maintain access to existing electrical installations which remain active. Modify installation or provide access panel as appropriate.
- C. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified. This includes the extension of the circuit from the last active device to the next device in the system to be activated.
- D. Equipment removal in certain locations may require the installation of a junction box to reconnect circuits that remain in operation. Extend conduit and wiring as required to maintain power to remaining equipment.
- E. Contractor shall remove and install all ceiling tiles as required for the execution of electrical work that is outside the contract limits of construction. Contractor shall replace ceiling tiles with identical material where damaged by this Contractor.
- F. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- G. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes x-ray or similar non-destructive means.
- H. Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

### 3.3 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or are to be reused.
- B. Panelboards: Within the project scope. Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- C. Luminaries: Remove existing luminaires for cleaning. Use mild detergent to clean all exteriors and interior surface, rinse with clean water and wipe dry. Replace lamps, ballasts, and broken electrical parts. Replacement parts shall match specified components for new fixtures of same type when applicable.
- D. Electrical items (i.e., lighting fixtures, panelboard motor controllers, disconnects, switches, conduit, wire, etc.) Removed and not relocated remain the property of the owner. The contractor shall dispose of material the owner does not want.

### 3.4 INSTALLATION

- A. Install relocated materials and equipment under the provisions of Division 26 Specifications.

**END OF SECTION 260502**

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## **SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER 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. Section Includes:

1. Copper building wire rated 600 V or less.
2. Connectors, splices, and terminations rated 600 V and less.

- B. Related Requirements:

1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

#### **1.3 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Member company of NETA.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

### **PART 2 - PRODUCTS**

#### **2.1 COPPER BUILDING WIRE**

- A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

- B. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.
3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."

- C. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.

- D. Conductor Insulation:

1. Type THHN and Type THWN-2: Comply with UL 83.
2. Type XHHW-2: Comply with UL 44.

## 2.2 METAL-CLAD CABLE, TYPE MC

- A. MC Cable not allowed.

## 2.3 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
  - 1. Material: Copper.
  - 2. Type: One hole with barrels.
  - 3. Termination: Compression.

## **PART 3 - EXECUTION**

### 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper stranded.
- B. Branch Circuits: Copper stranded.
- C. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

### 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- C. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

- C. 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.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

### 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-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. 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 Section 260553 "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 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### 3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

### 3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Perform each of the following visual and electrical tests:
    - a. Inspect exposed sections of conductor and cable for physical damage.

- b. Inspect compression-applied connectors for correct cable match and indentation.
  - c. Inspect for correct identification.
  - d. Inspect cable jacket and condition.
  - e. Continuity test on each conductor and cable.
- B. Cables will be considered defective if they do not pass tests and inspections and shall be replaced.

**END OF SECTION 260519**

## **SECTION 260523 - CONTROL-VOLTAGE ELECTRICAL POWER 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:
1. Low-voltage control cabling.
  2. Control-circuit conductors.
  3. Identification products.

#### **1.3 DEFINITIONS**

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.

#### **1.4 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Accredited by NETA.
1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

### **PART 2 - PRODUCTS**

#### **2.1 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.
- B. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
1. Flame Travel Distance: 60 inches or less.
  2. Peak Optical Smoke Density: 0.5 or less.
  3. Average Optical Smoke Density: 0.15 or less.

- C. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- D. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

## 2.2 LOW-VOLTAGE CONTROL CABLE

- A. Paired Cable: NFPA 70, Type CMG.
  - 1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
  - 2. PVC insulation.
  - 3. Unshielded.
  - 4. PVC jacket.
  - 5. Flame Resistance: Comply with UL 1685.
- B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
  - 1. One pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
  - 2. PVC insulation.
  - 3. Unshielded.
  - 4. PVC jacket.
  - 5. Flame Resistance: Comply with NFPA 262.

## 2.3 CONTROL-CIRCUIT CONDUCTORS

- A. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- B. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.
- C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Test cables on receipt at Project site.
  - 1. Test each pair of twisted pair cable for open and short circuits.

### 3.2 INSTALLATION OF RACEWAYS AND BOXES

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
  - 1. Flexible metal conduit shall not be used.

- B. Comply with TIA-569-D for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Cables serving a common system may be grouped in a common raceway. Install network cabling and control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
2. Do not install bruised, kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable.
3. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.
4. Support: Do not allow cables to lie on removable ceiling tiles.
5. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.
6. Provide strain relief.
7. Keep runs short. Allow extra length for connecting to terminals. Do not bend cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
8. Ground wire shall be copper, and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.

C. Installation of Control-Circuit Conductors:

1. Install wiring in raceways.
2. Use insulated spade lugs for wire and cable connection to screw terminals.
3. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

### 3.4 REMOVAL OF CONDUCTORS AND CABLES

A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

### 3.5 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits; No 14 AWG.
2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

**3.6 IDENTIFICATION**

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

**END OF SECTION 260523**



## **SECTION 260529 - 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. Section Includes:
  - 1. Hangers and supports for electrical equipment and systems.

### **PART 2 - PRODUCTS**

#### **2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS**

- A. Channel Dimensions: Selected for applicable load criteria.
- B. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
- C. Rated Strength: Selected to suit applicable load criteria.
- D. Stainless steel supports, fittings and hardware shall be ASTM type 316 with polished finish. Stainless steel screws, nuts, and bolts shall be ASTM type 316N2-33.
- E. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- F. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- G. 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 malleable iron.
- H. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
  - 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 A 325.
5. Toggle Bolts: All-steel springhead type.
6. Hanger Rods: Threaded steel.
7. Zamac nail type masonry anchors are prohibited.

## **PART 3 - EXECUTION**

### **3.1 APPLICATION**

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
  1. NECA 1.
  2. NECA 101
- B. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- C. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- D. 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 single-bolt conduit clamps.

### **3.2 SUPPORT INSTALLATION**

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT IMC and RMC may be supported by openings through structure members, according to NFPA 70.
- C. 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.
- D. 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 New Concrete: Bolt to concrete inserts.
  2. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.

3. To Light Steel: Sheet metal screws.
  4. 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.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

**END OF SECTION 260529**

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## **SECTION 260533 - RACEWAYS 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. Section Includes:
  - 1. Metal conduits and fittings.
  - 2. Surface raceways.
  - 3. Boxes, enclosures, and cabinets.

#### **1.3 DEFINITIONS**

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.
- C. IMC: Intermediate metal conduit.

### **PART 2 - PRODUCTS**

#### **2.1 METAL CONDUITS AND FITTINGS**

- A. Metal Conduit:
  - 1. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. GRC: Comply with ANSI C80.1 and UL 6.
  - 3. IMC: Comply with ANSI C80.6 and UL 1242.
  - 4. EMT: Comply with ANSI C80.3 and UL 797.
  - 5. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- B. Metal Fittings:
  - 1. Comply with NEMA FB 1 and UL 514B.
  - 2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 3. Fittings, General: Listed and labeled for type of conduit, location, and use.
  - 4. Fittings for EMT:
    - a. Material: Steel.
    - b. Type: compression.

- 5. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- C. Joint Compound for IMC, or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

## 2.2 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Prime coated, ready for field painting.

## 2.3 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Metal Floor Boxes:
  - 1. Material: Cast metal.
  - 2. Type: Fully adjustable.
  - 3. Shape: Rectangular.
  - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- F. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- G. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- H. Gangable boxes are prohibited.

## **PART 3 - EXECUTION**

### 3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC.
  2. Concealed Conduit, Aboveground: GRC.
  3. Underground Conduit: RNC, direct buried.
  4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
1. Exposed, Not Subject to Physical Damage: EMT.
  2. Exposed, Not Subject to Severe Physical Damage: EMT.
  3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
  5. Damp or Wet Locations: GRC.
  6. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 3R powder coated steel in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  2. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
  3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

### 3.2 INSTALLATION

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- D. Complete raceway installation before starting conductor installation.
- E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.

- F. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. 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.
- J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- K. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- L. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- M. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- N. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- O. 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. Cap underground raceways designated as spare above grade alongside raceways in use.
- P. Surface Raceways:
  - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
  - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- Q. Install raceway sealing fittings at accessible locations according to NFPA 70 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 according to NFPA 70.



- R. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  2. Where an underground service raceway enters a building or structure.
  3. Conduit extending from interior to exterior of building.
  4. Where otherwise required by NFPA 70.
- S. Expansion Fittings:
1. Expansion fittings shall be installed across expansion joints in structures and concrete construction where such joints are shown on the architectural and structural drawings.
- T. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
- U. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated.
- V. 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. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- W. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- X. Locate boxes so that cover or plate will not span different building finishes.
- Y. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- Z. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

### **3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS**

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

### **3.4 PROTECTION**

- A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

**END OF SECTION 260533**

## **SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING**

### **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 for raceway and cable penetration of non-fire-rated construction walls and floors.
  2. Grout.
  3. Silicone sealants.

### **PART 2 - PRODUCTS**

#### **2.1 SLEEVES**

- A. Wall Sleeves:
1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.

#### **2.2 GROUT**

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

#### **2.3 SILICONE SEALANTS**

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

## **PART 3 - EXECUTION**

### **3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS**

- A. Comply with NECA 1.
- B. 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.

### **3.2 FIELD QUALITY CONTROL**

- A. Inspect installed sleeve and sleeve-seal installations and associated firestopping for damage and faulty work. Replace sleeve and sleeve-seals that are damaged or faulty.

**END OF SECTION 260544**

## **SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
1. Identification for conductors.
  2. Underground-line warning tape.
  3. Equipment identification labels.

#### **1.2 QUALITY ASSURANCE**

- A. Comply with ANSI A13.1.
- B. Comply with NFPA 70.
- C. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

#### **1.3 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.

### **PART 2 - PRODUCTS**

#### **2.1 CONDUCTOR IDENTIFICATION MATERIALS**

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.

#### **2.2 EQUIPMENT IDENTIFICATION LABELS**

- A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.

### **PART 3 - EXECUTION**

#### **3.1 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.

### 3.2 IDENTIFICATION SCHEDULE

- A. Power-Circuit Conductor Identification, 600 V or Less: For conductors in pull and junction boxes use color-coding conductor tape to identify the phase.
  - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded branch-circuit conductors.
    - a. Color shall be factory applied.
    - b. Colors for 208/120-V Circuits:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Phase C: Blue.
    - c. 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.
- B. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.
- C. Control-Circuit Conductor Termination Identification: For identification at terminations provide self-adhesive vinyl labels with the conductor designation.
- D. Junction and Pullbox Identification. The following junction and pullboxes shall be identified utilizing spray-painted covers:
  - 1. Secondary Power, 208Y/120V – White.
- E. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the 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: Self-adhesive, 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 two 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.
  - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
2. Equipment to Be Labeled:
- a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive, engraved, laminated acrylic or melamine label.
  - b. Enclosures and electrical cabinets.
  - c. Enclosed switches.
  - d. Contactors.

**END OF SECTION 260553**

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## **SECTION 260923 – 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. Section Includes:
  - 1. Indoor occupancy sensors.
- B. Related Requirements:
  - 1. Division 26 Section "Wiring Devices" for manual light switches.

#### **1.3 SYSTEM DESCRIPTION**

- A. Occupancy Sensors
  - 1. Occupancy sensors shown on drawings are intended to show control intent. Quantities and locations are approximate and may not include all devices required for 100% coverage to meet energy code requirements. It shall be the contractor's responsibility to provide a complete Occupancy Sensor system based on the performance requirements of this specification and energy code requirements.

#### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: Show installation details for occupancy sensors.
  - 1. Floor plans indicating exact quantity and locations of devices for 100% sensor coverage based on manufacturer's requirements.
  - 2. Interconnection diagrams showing field-installed wiring.
  - 3. Include diagrams for power, signal, and control wiring.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For each type of lighting control device to include in emergency, operation, and maintenance manuals.

### **PART 2 - PRODUCTS**

#### **2.1 INDOOR OCCUPANCY SENSORS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Sensor Switch as indicated on drawings or comparable product by one of the following:
1. Hubbell Building Automation, Inc. (Construction Documents high bay occupancy sensor is designed around this manufacturer)
  2. Leviton Mfg. Company Inc.
  3. Watt Stopper
  4. Cooper Industries, Inc.
- B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state indoor occupancy sensors with a separate power pack.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off at 30 minutes.
  3. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor is powered from the power pack.
  4. Power Pack: 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. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
  5. Mounting:
    - a. Sensor: Suitable for mounting in any position on a standard outlet box.
    - b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
    - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
  6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
  7. Bypass Switch: Override the "on" function in case of sensor failure.
  8. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).
- D. Ultrasonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).

- E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is 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- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).

## 2.2 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Sensor Switch as specified on drawings or comparable product by one of the following:
1. Leviton Mfg. Company Inc.
  2. Watt Stopper
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
  3. Switch Rating: Not less than 800-VA at 120 V, 1200-VA at 277 V.
- C. Wall-Switch Sensor:
1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft..
  2. Sensing Technology: Passive Infrared.
  3. Switch Type: SP and dual circuit, field selectable automatic "on," or manual "on" automatic "off."
  4. Voltage: Dual voltage, 120 and 277 V.
  5. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
  6. Concealed, field-adjustable, "off" time-delay selector at 30 minutes.

## 2.3 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 Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

## **PART 3 - EXECUTION**

### **3.1 SENSOR INSTALLATION**

- 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 systems, and partition assemblies.
- B. 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 WIRING INSTALLATION**

- A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."
- B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- C. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

### **3.3 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.

### **3.4 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
  - 1. Operational Test: After installing time switches and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- B. Lighting control devices will be considered defective if they do not pass tests and inspections.

### 3.5    ADJUSTING

- A. Occupancy Adjustments: When requested within 3 months from date of Substantial Completion, provide on-site assistance in adjusting sensors to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
  - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
  - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
  - 3. Align high-bay occupancy sensors using manufacturer's laser aiming tool.

**END OF SECTION 260923**

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## **SECTION 262726 - WIRING DEVICES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
1. Toggle switches, 120/277 V, 20 A.
  2. Wall plates.

#### **1.2 DEFINITIONS**

- A. AFCI: Arc-fault circuit interrupter.
- B. BAS: Building automation system.
- C. EMI: Electromagnetic interference.
- D. GFCI: Ground-fault circuit interrupter.
- E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- F. RFI: Radio-frequency interference.
- G. SPD: Surge protective device.

#### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.

#### **1.4 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.

#### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

#### **1.6 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.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL WIRING-DEVICE REQUIREMENTS**

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Comply with NEMA WD 1.
- C. 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.
- D. Device Color:
  - 1. Wiring Devices Connected to Normal Power System: Ivory unless otherwise indicated or required by NFPA 70 or device listing.
- E. Wall Plate Color: For plastic covers, match device color.
- F. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

### **2.2 TOGGLE SWITCHES, 120/277 V, 20 A**

- A. Single-Pole Switches, 120/277 V, 20 A:
  - 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. Cooper; AH1221.
    - b. Hubbell; HBL1221.
    - c. Leviton; 1221-2.
    - d. Pass & Seymour; CSB20AC1.
  - 2. Standards: Comply with UL 20 and FS W-S-896.
- B. Three-Way Switches, 120/277 V, 20 A:
  - 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. Cooper; AH1223.
    - b. Hubbell; HBL1223.
    - c. Leviton; 1223-2.
    - d. Pass & Seymour; CSB20AC3.
  - 2. Comply with UL 20 and FS W-S-896.



## 2.3 WALL PLATES

- A. Single Source: Obtain wall plates from same manufacturer of wiring devices.
- B. Single and combination types shall match corresponding wiring devices.
  - 1. Plate-Securing Screws: Metal with head color to match plate finish.
  - 2. Material for Finished Spaces: Metal with head to match plate finish.
  - 3. Material for Unfinished Spaces: Galvanized steel.
- C. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant thermoplastic with lockable cover.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
  - 1. Protect installed devices and their boxes. 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 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 right 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 comply with 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. Install devices and assemblies level, plumb, and square with building lines.
  2. Remove wall plates and protect devices and assemblies during painting.
  3. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
  4. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
  5. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
  6. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
  7. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
  8. Use a torque screwdriver when a torque is recommended or required by manufacturer.
  9. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
  10. Tighten unused terminal screws on the device.
- E. 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.
- F. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- G. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

### 3.2 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with white-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

**END OF SECTION 262726**

## **SECTION 262813 - FUSES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in enclosed switches.

#### **1.2 QUALITY ASSURANCE**

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.
- 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 NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.

#### **1.3 PROJECT CONDITIONS**

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F (5 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

#### **1.4 COORDINATION**

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

### **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. Cooper Bussmann, Inc.
  2. Edison Fuse, Inc.
  3. Ferraz Shawmut, Inc.
  4. Littelfuse, Inc.

## 2.2 CARTRIDGE FUSES

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

## **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.

### 3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
  - 1. Motor Branch Circuits: Class RK1, time delay.
  - 2. Other Branch Circuits: Class RK1, time delay.
  - 3. Control Circuits: Class CC, time delay.

### 3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

### 3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

**END OF SECTION 262813**

## **SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Enclosures.

#### **1.2 ACTION 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.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

#### **1.3 CLOSEOUT SUBMITTALS**

A. 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.

#### **1.4 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. 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: Two for each size and type.

## 1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer. Manufacturer shall match switchboard manufacturer.
- 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 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 (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
  - 2. Altitude: Not exceeding 6600 feet (2010 m).

## 1.7 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

## **PART 2 - PRODUCTS**

### 2.1 FUSIBLE SWITCHES

- 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. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 3. Siemens Energy & Automation, Inc.
  - 4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. 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. Hookstick Handle: Allows use of a hookstick to operate the handle.
5. Lugs: Mechanical type, suitable for number, size, and conductor material.
6. Service-Rated Switches: Labeled for use as service equipment.

## 2.2 NONFUSIBLE SWITCHES

- 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. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  3. Siemens Energy & Automation, Inc.
  4. Square D; a brand of Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. 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. Hookstick Handle: Allows use of a hookstick to operate the handle.
  4. Lugs: Mechanical type, suitable for number, size, and conductor material.

## 2.3 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location. Provide the following minimum requirements, unless noted otherwise on the drawings.
  1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  2. Outdoor Locations: NEMA 250, Type 3R.

## **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.

### 3.2    INSTALLATION

- A.    Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B.    Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C.    Install fuses in fusible devices.
- D.    Comply with NECA 1.

### 3.3    IDENTIFICATION

- A.    Comply with requirements in Section 260553 "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.

### 3.4    FIELD QUALITY CONTROL

- A.    Tests and Inspections:
  - 1.    Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2.    Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3.    Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- B.    Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

### 3.5    ADJUSTING

- A.    Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

**END OF SECTION 262816**



## **SECTION 265100 – INTERIOR LIGHTING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

A. Section Includes:

1. Interior lighting fixtures.
2. Exit signs.
3. Lighting fixture supports.

B. Related Sections:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting.
2. Section 262726 "Wiring Devices."

#### **1.2 ACTION 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 (lumens, CCT, and CRI), 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. 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. Installation instructions.

#### **1.3 INFORMATIONAL SUBMITTALS**

A. Warranty: Sample of special warranty.

#### **1.4 CLOSEOUT SUBMITTALS**

A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

## 1.5 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. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

## 1.6 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 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.

## **PART 2 - PRODUCTS**

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

### 2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- C. 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.
- D. Diffusers:
  - 1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

- a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
  - b. UV stabilized.
2. Glass: Annealed crystal glass unless otherwise indicated.
- E. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
  1. Label shall include the following:
    - a. CCT and CRI for all luminaires.

### 2.3 LED LUMINAIRES

- A. LED Luminaires shall meet all DesignLights Consortium® (DesignLights.org) Product Qualification Criteria. This does not require that the luminaire be listed on the DesignLights Consortium's® Qualified Products List, but they must meet the Product Qualification Criteria. The technical requirements that the luminaire shall meet for each Application Category are:
  1. Minimum Light Output.
  2. Zonal Lumen Requirements.
  3. Minimum Luminaire Efficacy.
  4. Minimum CRI.
  5. L70 Lumen Maintenance.
  6. Minimum Luminaire Warranty of 10 years (not pro-rated) to include LED driver and all LED components
- B. Additional Requirements:
  1. Color Temperature as indicated on light fixture schedule.
  2. Color Consistency: LED manufacturer shall use a maximum 3-step MacAdam Ellipse binning process to achieve consistent fixture-to-fixture color for interior fixtures. Exterior fixtures shall use a maximum 5-step MacAdam Ellipse binning process.
  3. Glare Control: Exterior fixtures shall meet DesignLights Consortium's® criteria for Zonal Lumen Distribution requirements or Backlight-Uplight-Glare (BUG) standards for exterior fixtures.
  4. Luminaire shall be mercury-free, lead-free, and RoHS compliant.
  5. Luminaire shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.
  6. Light output of the LED system shall be measured using the absolute photometry method following IES LM-79 and IES LM-80 requirements and guidelines.
  7. Luminaire shall maintain 70% lumen output (L70) for a minimum of 50,000 hours.
  8. Driver shall have a rated life of 50,000 hours, minimum.
  9. Lumen output shall not depreciate more than 20% after 10,000 hours of use.
  10. Driver and LEDs shall be furnished from a single manufacturer to ensure compatibility.
  11. Luminaire Color Rendering Index (CRI) shall be a minimum of 80 for interior fixtures, and a minimum of 70 for exterior fixtures.

12. LED fixture shall be thermally designed as to not exceed the maximum junction temperature of the LED for the ambient temperature of the location the fixture is to be installed. Rated case temperature shall be suitable for operation in the ambient temperatures typically found for the intended installation. Exterior luminaires to operate in ambient temperatures of -20°F to 122°F (-29°C to 50°C).
13. LED driver shall have a minimum power factor (pf) of 0.9 and a maximum crest factor (cf) of 1.5 at full input power and across specified voltage range.
14. Luminaire shall operate normally for input voltage fluctuations of plus or minus 10 percent.
15. Luminaire shall have a maximum Total Harmonic Distortion (THD) of 20% at full input power and across specified voltage range.
16. Wiring connections to LED drivers shall utilize polarized quick-disconnects for field maintenance.
17. All connections to luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
18. Fuse Protections: All luminaires shall have built-in fuse protection. All power supply outputs shall be either fuse protected or be Polymeric Positive Temperature Coefficient (PTC)-protected as per Class 2 UL listing.
19. All luminaires shall be provided with knockouts for conduit connections.
20. The LED lighting fixture shall carry a limited 10-year warranty minimum for LED light engine(s)/board array, and driver(s).
21. Provide all of the following data on submittals:
  - a. Delivered Lumens
  - b. Input Watts
  - c. Efficacy
  - d. Color Rendering Index

## 2.4 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
  1. 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. Self Diagnostic

## 2.5 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" 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. Wires for Humid 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:
  - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
  - 2. The contractor shall install fixture supports as required to support all lighting fixtures adequately, providing extra steel work for the support of the fixtures if required. Any components necessary for mounting fixtures shall be provided by the contractor.
- B. 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. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
- C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Bond fixtures and metal accessories to branch circuit equipment grounding conductor.

### 3.2 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.3    FIELD QUALITY CONTROL

- A.    Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
  
- B.    Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

**END OF SECTION 265100**

## **SECTION 265600 - EXTERIOR LIGHTING**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

A. Section Includes:

1. Exterior luminaires with lamps and ballasts.
2. Poles and accessories.

B. Related Sections:

1. Section 265100 "Interior Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

#### **1.2 ACTION SUBMITTALS**

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
2. Details of attaching luminaires and accessories.
3. Details of installation and construction.
4. Luminaire materials.
5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
  - a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
6. Drivers, including energy-efficiency data.
7. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
8. Materials, dimensions, and finishes of poles.
9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.
10. Anchor bolts for poles.

B. Shop Drawings: 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. Anchor-bolt templates keyed to specific poles and certified by manufacturer.

#### **1.3 INFORMATIONAL SUBMITTALS**

A. Warranty: Sample of special warranty.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and poles to include in emergency, operation, and maintenance manuals.

#### 1.5 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. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. Provide one (1) of each type of LED module, light bar, or array (if applicable). If the LED's are integrated into the fixture and are not separate components, then extra LED's are not required.

#### 1.6 QUALITY ASSURANCE

- A. 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.
- 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 IEEE C2, "National Electrical Safety Code."

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Package aluminum poles for shipping according to ASTM B 660.
- B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.
- C. Retain factory-applied pole wrappings on metal poles until right before pole installation. For poles with nonmetallic finishes, handle with web fabric straps.

#### 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
  - 1. Warranty Period for Luminaires: Five (5) years from date of Substantial Completion.
  - 2. Warranty Period for Metal Corrosion: Five (5) years from date of Substantial Completion.
  - 3. Warranty Period for Color Retention: Five (5) years from date of Substantial Completion.



## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

### **2.2 GENERAL REQUIREMENTS FOR LUMINAIRES**

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
- B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- J. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- K. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
  - 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

- L. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
  - 1. Refer to Lighting Fixture Schedule for additional requirements.
- M. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

### 2.3 LED LUMINAIRES

- A. LED Luminaires shall meet all DesignLights Consortium® (DesignLights.org) Product Qualification Criteria. This does not require that the luminaire be listed on the DesignLights Consortium's® Qualified Products List, but they must meet the Product Qualification Criteria. The technical requirements that the luminaire shall meet for each Application Category are:
  - 1. Minimum Light Output.
  - 2. Zonal Lumen Requirements.
  - 3. Minimum Luminaire Efficacy.
  - 4. Minimum CRI.
  - 5. L70 Lumen Maintenance.
  - 6. Minimum Luminaire Warranty of five (5) years (not pro-rated) to include LED driver and all LED components.
- B. Additional Requirements:
  - 1. Color Temperature as indicated on the Light Fixture Schedule.
  - 2. Color Consistency: LED manufacturer shall use a maximum 3-step MacAdam Ellipse binning process to achieve consistent fixture-to-fixture color for interior fixtures. Exterior fixtures shall use a maximum 5-step MacAdam Ellipse binning process.
  - 3. Glare Control: Exterior fixtures shall meet DesignLights Consortium's® criteria for Zonal Lumen Distribution requirements or Backlight-Uplight-Glare (BUG) standards for exterior fixtures.
  - 4. Luminaire shall be mercury-free, lead-free, and RoHS compliant.
  - 5. Luminaire shall comply with FCC 47 CFR part 15 non-consumer RFI/EMI standards.
  - 6. Light output of the LED system shall be measured using the absolute photometry method following IES LM-79 and IES LM-80 requirements and guidelines.
  - 7. Luminaire shall maintain 70% lumen output (L70) for a minimum of 50,000 hours.
  - 8. Driver shall have a rated life of 50,000 hours, minimum.
  - 9. Lumen output shall not depreciate more than 20% after 10,000 hours of use.
  - 10. Driver and LEDs shall be furnished from a single manufacturer to ensure compatibility.
  - 11. Luminaire Color Rendering Index (CRI) shall be a minimum of 80 for interior fixtures, and a minimum of 70 for exterior fixtures.
  - 12. LED fixture shall be thermally designed as to not exceed the maximum junction temperature of the LED for the ambient temperature of the location the fixture is to be installed. Rated case temperature shall be suitable for operation in the ambient temperatures typically found for the intended installation. Exterior luminaires to operate in ambient temperatures of -20°F to 122°F (-29°C to 50°C).

13. LED driver shall have a minimum power factor (pf) of 0.9 and a maximum crest factor (cf) of 1.5 at full input power and across specified voltage range.
14. Luminaire shall operate normally for input voltage fluctuations of plus or minus 10 percent.
15. Luminaire shall have a maximum Total Harmonic Distortion (THD) of 20% at full input power and across specified voltage range.
16. Wiring connections to LED drivers shall utilize polarized quick-disconnects for field maintenance.
17. All connections to luminaires shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.
18. Fuse Protections: All luminaires shall have built-in fuse protection. All power supply outputs shall be either fuse protected or be Polymeric Positive Temperature Coefficient (PTC)-protected as per Class 2 UL listing.
19. All luminaires shall be provided with knockouts for conduit connections.
20. The LED lighting fixture shall carry a limited 5-year warranty minimum for LED light engine(s)/board array, and driver(s).
21. Provide all of the following data on submittals:
  - a. Delivered lumens
  - b. Input watts
  - c. Efficacy
  - d. Color rendering index.

## **PART 3 - EXECUTION**

### **3.1 LUMINAIRE INSTALLATION**

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
- C. Adjust luminaires that require field adjustment or aiming.

### **3.2 CORROSION PREVENTION**

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

### **3.3 GROUNDING**

1. Bond each luminaire, all metal accessories, pole and grounding electrode to the branch circuit equipment ground conductor with a separate ground wire sized per NEC.

### **3.4 FIELD QUALITY CONTROL**

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.

- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

**END OF SECTION 265600**

## ITEM X-100 GENERAL PAY ITEMS

### DESCRIPTION

**100-1.1** This item shall consist of work and operations, but is not limited to, work and operations necessary for the movement of personnel, equipment, material and supplies to and from the project site for work on the project except as provided in the contract as separate pay items.

### MATERIALS

**100-2.1 Posted Notices.** Prior to commencement of construction activities the Contractor must post the following documents in a prominent and accessible place where they may be easily viewed by all employees of the prime Contractor and by all employees of subcontractors engaged by the prime Contractor. These notices must remain posted until final acceptance of the work by the Owner. The Contractor shall replace documents as requested by Owner or Engineer should they become damaged due to weather or other reasons.

a. Equal Employment Opportunity (EEO) Poster “Equal Employment Opportunity is the Law” in accordance with the Office of Federal Contract Compliance Programs Executive Order 11246, as amended

b. Davis Bacon Wage Poster (WH 1321) - DOL “Notice to All Employees” Poster (if Davis Bacon wages are required)

c. Applicable Davis-Bacon Wage Rate Determination (if Davis Bacon wages are required)

**100-2.2 Construction Safety and Phasing.** All materials required for Contractor compliance with the approved Construction Safety and Phasing Plan and Safety Plan Compliance Document shall be as indicated on the plan sheets and as directed by the Engineer.

**100-2.3 Permits** Permit applications and payments will be made by the Contractor. The following list is for permits that may be required for this project and may not be all inclusive. It is the responsibility of the contractor to determine if other permits are required.

a. **Soil Erosion and Sedimentation Control Permit.** The contractor shall apply for a permit by contacting the Calhoun County

b. **NPDES Notice of Coverage.** The Contractor shall obtain the NPDES Notice of Coverage from the Storm Water Administration, Surface Water Quality Division, Michigan Department of Environmental Quality, PO Box 30438, Lansing, MI 48909-7938, 517-241-8993. Following permanent soil stabilization, the Contractor will also file the Notice of Termination with the same office noted above.

The Contractor shall be responsible for providing the Certified Storm Water Operator who will inspect soil erosion and sedimentation control measures.

### END OF ITEM X-100

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## ITEM P-152 EXCAVATION, SUBGRADE, AND EMBANKMENT

### DESCRIPTION

**152-1.1** This item covers excavation, disposal, placement, and compaction of all materials within the limits of the work required to construct safety areas, runways, taxiways, aprons, and intermediate areas as well as other areas for drainage, building construction, parking, or other purposes in accordance with these specifications and in conformity to the dimensions and typical sections shown on the plans.

**152-1.2 Classification.** All material excavated shall be classified as defined below:

**a. Unclassified excavation.** Unclassified excavation shall consist of the excavation and disposal of all material, regardless of its nature.

**152-1.3 Unsuitable excavation.** Any material containing vegetable or organic matter, such as muck, peat, organic silt, or sod shall be considered unsuitable for use in embankment construction. Material, suitable for topsoil may be used on the embankment slope when approved by the Engineer.

### CONSTRUCTION METHODS

**152-2.1 General.** Before beginning excavation, grading, and embankment operations in any area, the area shall be completely cleared and grubbed.

The suitability of material to be placed in embankments shall be subject to approval by the Engineer. All unsuitable material shall be disposed of offsite. All suitable material shall be either used in the formation of embankments within the project limits or disposed of offsite. All waste areas shall be graded to allow positive drainage of the area and of adjacent areas. The surface elevation of waste areas shall not extend above the surface elevation of adjacent usable areas of the airport, unless specified on the plans or approved by the Engineer.

When the Contractor's excavating operations encounter artifacts of historical or archaeological significance, the operations shall be temporarily discontinued and the Engineer notified per subsection 70-20. At the direction of the Engineer, the Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and allow for their removal. Such excavation will be paid for as extra work.

Those areas outside of the limits of the pavement areas where the top layer of soil material has become compacted by hauling or other Contractor activities shall be scarified and disked to a depth of 4 inches (100 mm), to loosen and pulverize the soil.

If it is necessary to interrupt existing surface drainage, sewers or under-drainage, conduits, utilities, or similar underground structures, the Contractor shall be responsible for and shall take all necessary precautions to preserve them or provide temporary services. When such facilities are encountered, the Contractor shall notify the Engineer, who shall arrange for their removal if necessary. The Contractor, at his or her expense, shall satisfactorily repair or pay the cost of all damage to such facilities or structures that may result from any of the Contractor's operations during the period of the contract.

**152-2.2 Excavation.** No excavation shall be started until the work has been staked out by the Contractor and the Engineer has reviewed and approved obtained from the Contractor, the survey notes of the elevations and measurements of the ground surface. All areas to be excavated shall be stripped of vegetation and topsoil. Topsoil shall be stockpiled for future use in areas designated on the plans or by the Engineer. All suitable excavated material shall be used in the formation of embankment, subgrade, or other purposes shown on the plans. All unsuitable material shall be disposed of as shown on the plans.

When the volume of the excavation exceeds that required to construct the embankments to the grades indicated, the excess shall be used to grade the areas of ultimate development or disposed as directed by the Engineer. When the volume of excavation is not sufficient for constructing the embankments to the grades indicated, the deficiency shall be obtained from borrow areas.

The grade shall be maintained so that the surface is well drained at all times. When necessary, temporary drains and drainage ditches shall be installed to intercept or divert surface water that may affect the work.

**a. Selective grading.** Not Applicable.

**b. Undercutting.** Rock, shale, hardpan, loose rock, boulders, or other material unsatisfactory for safety areas, subgrades, roads, shoulders, or any areas intended for turf shall be excavated to a minimum depth of 12 inches (300 mm) below the subgrade or to the depth specified by the Engineer. Muck, peat, matted roots, or other yielding material, unsatisfactory for subgrade foundation, shall be removed to the depth specified. Unsuitable materials shall be disposed off the airport. The excavated area shall be backfilled with suitable material obtained from the grading operations or borrow areas and compacted to specified densities. The necessary backfill will constitute a part of the embankment. Where rock cuts are made, backfill with select material. Any pockets created in the rock surface shall be drained in accordance with the details shown on the plans.

**c. Overbreak.** Overbreak, including slides, is that portion of any material displaced or loosened beyond the finished work as planned or authorized by the Engineer. All overbreak shall be graded or removed by the Contractor and disposed of as directed by the Engineer. The Engineer shall determine if the displacement of such material was unavoidable and his or her decision shall be final. Payment will not be made for the removal and disposal of overbreak that the Engineer determines as avoidable. Unavoidable overbreak will be classified as "Unclassified Excavation."

**d. Removal of utilities.** The removal of existing structures and utilities required to permit the orderly progress of work will be accomplished by someone other than the Contractor; for example, the utility unless otherwise shown on the plans. All existing foundations shall be excavated at least 2 feet (60 cm) below the top of subgrade or as indicated on the plans, and the material disposed of as directed by the Engineer. All foundations thus excavated shall be backfilled with suitable material and compacted as specified.

**e. Compaction requirements.** The subgrade under areas to be paved shall be compacted to a depth of 8" and to a density of not less than 100 percent of the maximum density as determined by ASTM D698. The material to be compacted shall be within  $\pm 2\%$  of optimum moisture content before being rolled to obtain the prescribed compaction (except for expansive soils).

The in-place field density shall be determined in accordance with ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. Stones or rock fragments larger than 4 inches (100 mm) in their greatest dimension will not be permitted in the top 6 inches (150 mm) of the subgrade. The finished grading operations, conforming to the typical cross-section, shall be completed and maintained at least 1,000 feet (300 m) ahead of the paving operations or as directed by the Engineer.

All loose or protruding rocks on the back slopes of cuts shall be pried loose or otherwise removed to the slope finished grade line. All cut-and-fill slopes shall be uniformly dressed to the slope, cross-section, and alignment shown on the plans or as directed by the Engineer.

Blasting shall not be allowed.

All proctor and density testing shall be completed by the contractor at their own expense. Test reports shall be submitted to the Engineer at the end of each day at a minimum. No layer shall be covered by the next layer prior to the testing results being reviewed by the Engineer.



**f. Proof rolling.** After compaction is completed, the subgrade area shall be proof rolled with a heavy pneumatic-tired roller having four or more tires abreast, each tire loaded to a minimum of 30,000 pounds and inflated to a minimum of 125 psi in the presence of the Engineer. Apply a minimum of 1 coverage, or as specified by the Engineer, to all paved areas. A coverage is defined as the application of one tire print over the designated area. Soft areas of subgrade that deflect more than 1 inch (25 mm) or show permanent deformation greater than 1 inch (25 mm) shall be removed and replaced with suitable material or reworked to conform to the moisture content and compaction requirements in accordance with these specifications.

**152-2.3 Borrow excavation.** Borrow areas within the airport property are indicated on the plans. Borrow excavation shall be made only at these designated locations and within the horizontal and vertical limits as staked or as directed by the Engineer.

When borrow sources are outside the boundaries of the airport property, it shall be the Contractor's responsibility to locate and obtain the borrow sources, subject to the approval of the Engineer. The Contractor shall notify the Engineer at least 15 days prior to beginning the excavation so necessary measurements and tests can be made. All borrow pits shall be opened up to expose the various strata of acceptable material to allow obtaining a uniform product. All unsuitable material shall be disposed of by the Contractor. Borrow pits shall be excavated to regular lines to permit accurate measurements, and they shall be drained and left in a neat, presentable condition with all slopes dressed uniformly.

**152-2.4 Drainage excavation.** Drainage excavation shall consist of excavating for drainage ditches such as intercepting; inlet or outlet ditches; for temporary levee construction; or for any other type as designed or as shown on the plans. The work shall be performed in sequence with the other construction. Intercepting ditches shall be constructed prior to starting adjacent excavation operations. All satisfactory material shall be placed in embankment fills; unsuitable material shall be placed in designated waste areas or as directed by the Engineer. All necessary work shall be performed true to final line, elevation, and cross-section. The Contractor shall maintain ditches constructed on the project to the required cross-section and shall keep them free of debris or obstructions until the project is accepted. There shall be no separate payment for drainage excavation, it will be considered incidental to the project.

**152-2.5 Preparation of embankment area.** Where an embankment is to be constructed to a height of 4 feet (1.2 m) or less, all sod and vegetative matter shall be removed from the surface upon which the embankment is to be placed. The cleared surface shall be broken up by plowing or scarifying to a minimum depth of 6 inches (150 mm) and shall then be compacted as indicated in paragraph 152-2.6. When the height of fill is greater than 4 feet (1.2 m), sod not required to be removed shall be thoroughly disked and recompacted to the density of the surrounding ground before construction of embankment.

Sloped surfaces steeper than one (1) vertical to four (4) horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches (300 mm) and compacted as specified for the adjacent fill.

No direct payment shall be made for the work performed under this section. The necessary clearing and grubbing and the quantity of excavation removed will be paid for under the respective items of work.

**152-2.6 Formation of embankments.** Embankments shall be formed in successive horizontal layers of not more than 8 inches (200 mm) in loose depth for the full width of the cross-section, unless otherwise approved by the Engineer.

The layers shall be placed, to produce a soil structure as shown on the typical cross-section or as directed by the Engineer. Materials such as brush, hedge, roots, stumps, grass and other organic matter, shall not be incorporated or buried in the embankment.

Earthwork operations shall be suspended at any time when satisfactory results cannot be obtained because of rain, freezing, or other unsatisfactory weather conditions in the field. Frozen material shall not be placed

in the embankment nor shall embankment be placed upon frozen material. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. The Contractor shall drag, blade, or slope the embankment to provide surface drainage at all times.

The material in each layer shall be within  $\pm 2\%$  of optimum moisture content before rolling to obtain the prescribed compaction. To achieve a uniform moisture content throughout the layer, the material shall be moistened or aerated as necessary. Samples of all embankment materials for testing, both before and after placement and compaction, will be taken for each 2000 square yards. Based on these tests, the Contractor shall make the necessary corrections and adjustments in methods, materials or moisture content to achieve the specified embankment density.

Rolling operations shall be continued until the embankment is compacted to not less than 95% of maximum density for noncohesive soils, and 90% of maximum density for cohesive soils as determined by ASTM D698. Under all areas to be paved, the embankments shall be compacted to a depth of 8" and to a density of not less than 100 percent of the maximum density as determined by ASTM D698.

On all areas outside of the pavement areas, no compaction will be required on the top 4 inches (100 mm).

The in-place field density shall be determined in accordance with ASTM 6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. The Engineer shall perform all density tests.

Compaction areas shall be kept separate, and no layer shall be covered by another layer until the proper density is obtained.

During construction of the embankment, the Contractor shall route all construction equipment evenly over the entire width of the embankment as each layer is placed. Layer placement shall begin in the deepest portion of the embankment fill. As placement progresses, the layers shall be constructed approximately parallel to the finished pavement grade line.

When rock and other embankment material are excavated at approximately the same time, the rock shall be incorporated into the outer portion of the embankment and the other material shall be incorporated under the future paved areas. Stones or fragmentary rock larger than 4 inches (100 mm) in their greatest dimensions will not be allowed in the top 6 inches (150 mm) of the subgrade. Rockfill shall be brought up in layers as specified or as directed by the Engineer and the finer material shall be used to fill the voids with forming a dense, compact mass. Rock or boulders shall not be disposed of outside the excavation or embankment areas, except at places and in the manner designated on the plans or by the Engineer.

When the excavated material consists predominantly of rock fragments of such size that the material cannot be placed in layers of the prescribed thickness without crushing, pulverizing or further breaking down the pieces, such material may be placed in the embankment as directed in layers not exceeding 2 feet (60 cm) in thickness. Each layer shall be leveled and smoothed with suitable equipment by distribution of spalls and finer fragments of rock. The layer shall not be constructed above an elevation 4 feet (1.2 m) below the finished subgrade.

There will be no separate measurement of payment for compacted embankment. All costs incidental to placing in layers, compacting, discing, watering, mixing, sloping, and other operations necessary for construction of embankments will be included in the contract price for excavation, borrow, or other items.

**152-2.7 Finishing and protection of subgrade.** After the subgrade is substantially complete, the Contractor shall remove any soft or other unstable material over the full width of the subgrade that will not compact properly. All low areas, holes or depressions in the subgrade shall be brought to grade with suitable select material. Scarifying, blading, rolling and other methods shall be performed to provide a thoroughly compacted subgrade shaped to the lines and grades shown on the plans.

Grading of the subgrade shall be performed so that it will drain readily. The Contractor shall protect the subgrade from damage and limit hauling over the finished subgrade to only traffic essential for construction purposes. All ruts or rough places that develop in the completed subgrade shall be graded and recompacted.

No subbase, base, or surface course shall be placed on the subgrade until the subgrade has been approved by the Engineer.

**152-2.8 Haul.** All hauling will be considered a necessary and incidental part of the work. No payment will be made separately or directly for hauling on any part of the work.

**152-2.9 Tolerances.** In those areas upon which a subbase or base course is to be placed, the top of the subgrade shall be of such smoothness that, when tested with a Contractor-furnished 12-foot (3.7-m) straightedge applied parallel and at right angles to the centerline, it shall not show any deviation in excess of 1/2 inch (12 mm), or shall not be more than 0.05 feet (15 mm) from true grade as established by grade hubs. Any deviation in excess of these amounts shall be corrected by loosening, adding, or removing materials; reshaping; and recompacting.

On safety areas, intermediate and other designated areas, the surface shall be of such smoothness that it will not vary more than 0.10 feet (3 mm) from true grade as established by grade hubs. Any deviation in excess of this amount shall be corrected by loosening, adding or removing materials, and reshaping.

**152-2.10 Topsoil.** When topsoil is specified or required as shown on the plans or under Item T-905, it shall be salvaged from stripping or other grading operations. The topsoil shall meet the requirements of Item T-905. If, at the time of excavation or stripping, the topsoil cannot be placed in its final section of finished construction, the material shall be stockpiled at approved locations. Stockpiles shall not be placed within 250 feet of runway pavement or 100 feet of taxiway pavement and shall not be placed on areas that subsequently will require any excavation or embankment fill. If, in the judgment of the Engineer, it is practical to place the salvaged topsoil at the time of excavation or stripping, the material shall be placed in its final position without stockpiling or further rehandling.

Upon completion of grading operations, stockpiled topsoil shall be handled and placed as directed, or as required in Item T-905. There shall be no payment for rehandling of topsoil, either to spread on site or dispose of offsite.

No direct payment will be made for topsoil under Item P-152.

Type 1.

### TESTING REQUIREMENTS

ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft <sup>3</sup> (600 kN-m/m <sup>3</sup> ))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft <sup>3</sup> (2700 kN-m/m <sup>3</sup> ))
ASTM D2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

### END OF ITEM P-152

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## ITEM P-156 TEMPORARY AIR AND WATER POLLUTION, SOIL EROSION, AND SILTATION CONTROL

### DESCRIPTION

**156-1.1** This item shall consist of temporary control measures as shown on the plans or as ordered by the Engineer during the life of a contract to control water pollution, soil erosion, and siltation through the use of silt fences, berms, dikes, dams, sediment basins, fiber mats, gravel, mulches, grasses, slope drains, and other erosion control devices or methods.

The temporary erosion control measures contained herein shall be coordinated with the permanent erosion control measures specified as part of this contract to the extent practical to assure economical, effective, and continuous erosion control throughout the construction period.

Temporary control may include work outside the construction limits such as borrow pit operations, equipment and material storage sites, waste areas, and temporary plant sites.

Temporary control measures shall be design, installed and maintained to minimize the creation of wildlife attractants that have the potential to attract hazardous wildlife on or near public-use airports.

### MATERIALS

**156-2.1 Grass.** Grass that will not compete with the grasses sown later for permanent cover per Specification T-901 shall be a quick-growing species (such as ryegrass, Italian ryegrass, or cereal grasses) suitable to the area providing a temporary cover. Selected grass species shall not create a wildlife attractant.

**156-2.2 Mulches.** Mulches may be hay, straw, fiber mats, netting, bark, wood chips, or other suitable material reasonably clean and free of noxious weeds and deleterious materials per Specification T-908. Mulches shall not create a wildlife attractant.

**156-2.3 Fertilizer.** Fertilizer shall be a standard commercial grade and shall conform to all Federal and state regulations and to the standards of the Association of Official Agricultural Chemists.

**156-2.4 Slope drains.** Slope drains may be constructed of pipe, fiber mats, rubble, Portland cement concrete, bituminous concrete, or other materials that will adequately control erosion.

**156-2.5 Silt fence.** The silt fence shall consist of polymeric filaments which are formed into a stable network such that filaments retain their relative positions. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life. Silt fence shall meet the requirements of ASTM D6461.

**156-2.6 Other.** All other materials shall meet commercial grade standards and shall be approved by the Engineer before being incorporated into the project.

### CONSTRUCTION REQUIREMENTS

**156-3.1 General.** In the event of conflict between these requirements and pollution control laws, rules, or regulations of other Federal, state, or local agencies, the more restrictive laws, rules, or regulations shall apply.

The Engineer shall be responsible for assuring compliance to the extent that construction practices, construction operations, and construction work are involved.

**156-3.2 Schedule.** Prior to the start of construction, the Contractor shall submit schedules for accomplishment of temporary and permanent erosion control work for clearing and grubbing; grading; construction; paving; and structures at watercourses. The Contractor shall also submit a proposed method of erosion and dust control on haul roads and borrow pits and a plan for disposal of waste materials. Work shall not be started until the erosion control schedules and methods of operation for the applicable construction have been accepted by the Engineer.

**156-3.3 Construction details.** The Contractor will be required to incorporate all permanent erosion control features into the project at the earliest practicable time as outlined in the accepted schedule. Except where future construction operations will damage slopes, the Contractor shall perform the permanent seeding and mulching and other specified slope protection work in stages, as soon as substantial areas of exposed slopes can be made available. Temporary erosion and pollution control measures will be used to correct conditions that develop during construction that were not foreseen during the design stage; that are needed prior to installation of permanent control features; or that are needed temporarily to control erosion that develops during normal construction practices, but are not associated with permanent control features on the project.

Where erosion may be a problem, clearing and grubbing operations should be scheduled and performed so that grading operations and permanent erosion control features can follow immediately if project conditions permit; otherwise, temporary erosion control measures may be required.

The Engineer shall limit the area of clearing and grubbing, excavation, borrow, and embankment operations in progress, commensurate with the Contractor's capability and progress in keeping the finish grading, mulching, seeding, and other such permanent control measures current with the accepted schedule. If seasonal limitations make such coordination unrealistic, temporary erosion control measures shall be taken immediately to the extent feasible and justified as directed by the Engineer.

The Contractor shall provide immediate permanent or temporary pollution control measures to minimize contamination of adjacent streams or other watercourses, lakes, ponds, or other areas of water impoundment as directed by the Engineer. If temporary erosion and pollution control measures are required due to the Contractor's negligence, carelessness, or failure to install permanent controls as a part of the work as scheduled or directed by the Engineer, the work shall be performed by the Contractor and the cost shall be incidental to this item.

The Engineer may increase or decrease the area of erodible earth material that can be exposed at any time based on an analysis of project conditions.

The erosion control features installed by the Contractor shall be acceptably maintained by the Contractor during the construction period.

Whenever construction equipment must cross watercourses at frequent intervals, temporary structures should be provided.

Pollutants such as fuels, lubricants, bitumen, raw sewage, wash water from concrete mixing operations, and other harmful materials shall not be discharged into any waterways, impoundments or into natural or manmade channels.

**156-3.4 Installation, maintenance and removal of silt fences.** Silt fences shall extend a minimum of 16 inches (41 cm) and a maximum of 34 inches (86 cm) above the ground surface. Posts shall be set no more than 10 feet (3 m) on center. Filter fabric shall be cut from a continuous roll to the length required minimizing joints where possible. When joints are necessary, the fabric shall be spliced at a support post with a minimum 12-inch (300-mm) overlap and securely sealed. A trench shall be excavated approximately 4 inches (100 mm) deep by 4 inches (100 mm) wide on the upslope side of the silt fence. The trench shall be backfilled and the soil compacted over the silt fence fabric. The Contractor shall remove and dispose of silt that accumulates during construction and prior to establishment of permanent erosion control. The fence shall be maintained in good working condition until permanent erosion control is established. Silt fence

shall be removed upon approval of the Engineer. The Contractor is responsible for the removal/disposal of all temporary erosion/pollution control items and the restoration of those sites upon approval of the Engineer. This work will include the repair of any trenching for silt fence, removal of silt build-up, removal of fencing, barriers and silt bales and the associated stakes and the placing of seed or sod to restore those sites.

**MATERIAL REQUIREMENTS**

ASTM D6461	Standard Specification for Silt Fence Materials
AC 150/5200-33	Hazardous Wildlife Attractants

**END OF ITEM P-156**

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## ITEM P-501 PORTLAND CEMENT CONCRETE (PCC) PAVEMENT

### DESCRIPTION

**501-1.1** This work shall consist of pavement composed of portland cement concrete (PCC), without reinforcement constructed on a prepared underlying surface in accordance with these specifications and shall conform to the lines, grades, thickness, and typical cross-sections shown on the plans.

### MATERIALS

#### **501-2.1 Aggregates.**

- a. Reactivity.** Fine and Coarse aggregates to be used in all concrete shall be evaluated and tested by the Contractor for alkali-aggregate reactivity in accordance with both ASTM C1260 and ASTM C1567. Aggregate and mix proportion reactivity tests shall be performed for each project.

(1) Coarse and fine aggregate shall be tested separately in accordance with ASTM C1260. The aggregate shall be considered innocuous if the expansion of test specimens, tested in accordance with ASTM C1260, does not exceed 0.10% at 28 days (30 days from casting).

(2) Combined coarse and fine aggregate shall be tested in accordance with ASTM C1567, modified for combined aggregates, using the proposed mixture design proportions of aggregates, cementitious materials, and/or specific reactivity reducing chemicals. If lithium nitrate is proposed for use with or without supplementary cementitious materials, the aggregates shall be tested in accordance with Corps of Engineers (COE) Concrete Research Division (CRD) C662. If lithium nitrate admixture is used, it shall be nominal 30% ±0.5% weight lithium nitrate in water.

(3) If the expansion of the proposed combined materials test specimens, tested in accordance with ASTM C1567, modified for combined aggregates, or COE CRD C662, does not exceed 0.10% at 28 days, the proposed combined materials will be accepted. If the expansion of the proposed combined materials test specimens is greater than 0.10% at 28 days, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce the expansion to less than 0.10% at 28 days, or new aggregates shall be evaluated and tested.

**b. Fine aggregate.** Fine aggregate shall conform to the requirements of ASTM C33. Grading of the fine aggregate, as delivered to the mixer, shall conform to the requirements of ASTM C33 and shall have a fineness modulus of not less than 2.50 nor more than 3.40. The soundness loss shall not exceed 10% when sodium sulfate is used or 15% when magnesium sulfate is used, after five cycles, when tested per ASTM C88.

The amount of deleterious material in the fine aggregate shall not exceed the following limits:

**Limits for Deleterious Substances in Fine Aggregate for Concrete**

Deleterious material	ASTM	Percentage by Mass
Clay Lumps and friable particles	ASTM C142	1.0
Material finer than 0.075mm (No. 200 sieve)	ASTM C117	3.0
Lightweight particles	ASTM C123 using a medium with a density of Sp. Gr. of 2.0	0.5
Total of all deleterious Material		3.0

**c. Coarse aggregate.** Gradation, within the separated size groups, shall meet the coarse aggregate grading requirements of ASTM C33 when tested in accordance with ASTM C136. When the nominal maximum size of the aggregate is greater than one inch (25 mm), the aggregates shall be furnished in two size groups.

Aggregates delivered to the mixer shall consist of crushed stone, crushed or uncrushed gravel, air-cooled iron blast furnace slag, crushed recycled concrete pavement, or a combination. The aggregates should be free of ferrous sulfides, such as pyrite, that would cause “rust” staining that can bleed through pavement markings. Steel blast furnace slag shall not be permitted. The aggregate shall be composed of clean, hard, uncoated particles. Dust and other coating shall be removed from the aggregates by washing.

The percentage of wear shall be no more than 40% when tested in accordance with ASTM C131.

The quantity of flat, elongated, and flat and elongated particles in any size group coarser than 3/8 sieve (9 mm) shall not exceed 8% by weight when tested in accordance with ASTM D4791. A flat particle is defined as one having a ratio of width to thickness greater than 5. An elongated particle is one having a ratio of length to width greater than 5.

The soundness loss shall not exceed 12% when sodium sulfate is used or 18% when magnesium sulfate is used, after five cycles, when tested per ASTM C88.

The amount of deleterious material in the coarse aggregate shall not exceed the following limits:

**Limits for Deleterious Substances in Coarse Aggregate for Concrete**

Deleterious material	ASTM	Percentage by Mass
Clay Lumps and friable particles	ASTM C142	1.0
Material finer than No. 200 sieve (0.075mm)	ASTM C117	1.0
Lightweight particles	ASTM C123 using a medium with a density of Sp. Gr. of 2.0	0.5
Chert (less than 2.40 Sp Gr.)	ASTM C123 using a medium with a density of Sp. Gr. of 2.0)	1.0
Total of all deleterious Material		3.0

**Table 1. Gradation For Coarse Aggregate  
(ASTM C33)**

Sieve Designations (square openings)		Percentage by Weight Passing Sieves	
inch	mm	#4	#67
2-1/2	60	---	---
2	50	100	---
1-1/2	38	90-100	---
1	25	20-55	100
3/4	19	0-15	90-100
1/2	13	---	---
3/8	9	0-5	20-55
No. 4	4.75	---	0-10
No. 8	2.36	---	0-5

**(1) Aggregate susceptibility to durability (D) cracking.** Aggregates that have a history of D-cracking shall not be used.

**(2) Combined aggregate gradation.** If substituted for the grading requirements specified for coarse aggregate and for fine aggregate and when approved by the Engineer, the combined aggregate grading shall meet the following requirements:

(a) The materials selected and the proportions used shall be such that when the Coarseness Factor (CF) and the Workability Factor (WF) are plotted on a diagram as described in d. below, the point thus determined shall fall within the parallelogram described therein.

(b) The CF shall be determined from the following equation:

$$CF = (\text{cumulative percent retained on the } 3/8 \text{ in. sieve})(100) / (\text{cumulative percent retained on the No. 8 sieve})$$

(c) The Workability Factor WF is defined as the percent passing the No. 8 (2.36 mm) sieve based on the combined gradation. However, WF shall be adjusted, upwards only, by 2.5 percentage points for each 94 pounds (42 kg) of cementitious material per cubic meter yard greater than 564 pounds per cubic yard (335 kg per cubic meter).

(d) A diagram shall be plotted using a rectangular scale with WF on the Y-axis with units from 20 (bottom) to 45 (top), and with CF on the X-axis with units from 80 (left side) to 30 (right side). On this diagram a parallelogram shall be plotted with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-40), (CF-45, WF-32.5), and (CF-45, WF-44.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, the grading of each size of aggregate used and the proportions selected shall be changed as necessary.

**501-2.2 Cement.** Cement shall conform to the requirements of ASTM C150 Type I.

If aggregates are deemed innocuous when tested in accordance with paragraph 501-2.1.a.1 and accepted in accordance with paragraph 501-2.1.a.2, higher equivalent alkali content in the cement may be allowed if approved by the Engineer and FAA. If cement becomes partially set or contains lumps of caked cement, it shall be rejected. Cement salvaged from discarded or used bags shall not be used.

**501-2.3 Cementitious materials.**

**a. Fly ash.** Fly ash shall meet the requirements of ASTM C618, with the exception of loss of ignition, where the maximum shall be less than 6%. Fly ash for use in mitigating alkali-silica reactivity shall have a Calcium Oxide (CaO) content of less than 13% and a total available alkali content less than 3% per ASTM C311. Fly ash produced in furnace operations using liming materials or soda ash (sodium carbonate) as an additive shall not be acceptable. The Contractor shall furnish the previous three most recent, consecutive ASTM C618 reports for each source of fly ash proposed in the mix design, and shall furnish each additional report as they become available during the project. The reports can be used for acceptance or the material may be tested independently by the Engineer.

**b. Slag cement (ground granulated blast furnace(GGBF)).** Slag cement shall conform to ASTM C989, Grade 100 or Grade 120. Slag cement shall be used only at a rate between 25% and 55% of the total cementitious material by mass.

**c. Raw or calcined natural pozzolan.** Natural pozzolan shall be raw or calcined and conform to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and shall have a loss on ignition not exceeding 6%. Class N pozzolan for use in mitigating Alkali-Silica Reactivity shall have a total available alkali content less than 3%.

**501-2.4 Joint seal.** The joint seal for the joints in the concrete pavement shall meet the requirements of Item P-605 and shall be of the type specified in the plans.

**501-2.5 Isolation joint filler.** Premolded joint filler for isolation joints shall conform to the requirements of ASTM D1751 and shall be where shown on the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint, unless otherwise specified by the Engineer. When the use of more than one piece is required for a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or other positive fastening means satisfactory to the Engineer.

**501-2.6 Steel reinforcement.** *Not applicable*

**501-2.7 Dowel and tie bars.** Dowel bars shall be plain steel bars conforming to ASTM A615 and shall be free from burring or other deformation restricting slippage in the concrete. Before delivery to the construction site each dowel bar shall be epoxy coated per ASTM A1078. The dowels shall be coated with a bond-breaker recommended by the manufacturer. Dowel sleeves or inserts are not permitted. Grout retention rings shall be fully circular metal or plastic devices capable of supporting the dowel until the grout hardens.

Tie bars shall be deformed steel bars and conform to the requirements of ASTM A615. Tie bars designated as Grade 60 in ASTM A615 or ASTM A706 shall be used for construction requiring bent bars.

**501-2.8 Water.** Water used in mixing or curing shall be potable, clean, free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product, except that non-potable water, or water from concrete production operations, may be used if it meets the requirements of ASTM C1602.

**501-2.9 Material for curing concrete.** Curing materials shall conform to one of the following specifications:

- a. Liquid membrane-forming compounds for curing concrete shall conform to the requirements of ASTM C309, Type 2, Class B, or Class A if wax base only.
- b. White polyethylene film for curing concrete shall conform to the requirements of ASTM C171.
- c. White burlap-polyethylene sheeting for curing concrete shall conform to the requirements of ASTM C171.
- d. Waterproof paper for curing concrete shall conform to the requirements of ASTM C171.

**501-2.10 Admixtures.** The Contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the Engineer may require the Contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Subsequent tests may be made of samples taken by the Engineer from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

**a. Air-entraining admixtures.** Air-entraining admixtures shall meet the requirements of ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entrainment agent and any water reducer admixture shall be compatible.

**b. Water-reducing admixtures.** Water-reducing admixture shall meet the requirements of ASTM C494, Type A, B, or D. ASTM C494, Type F and G high range water reducing admixtures and ASTM C1017 flowable admixtures shall not be used.

**c. Other admixtures.** The use of set retarding, and set-accelerating admixtures shall be approved by the Engineer. Retarding shall meet the requirements of ASTM C494, Type A, B, or D and set-accelerating shall meet the requirements of ASTM C494, Type C. Calcium chloride and admixtures containing calcium chloride shall not be used.

**d. Lithium Nitrate.** The lithium admixture shall be a nominal 30% aqueous solution of Lithium Nitrate, with a density of 10 pounds/gallon (1.2 kg/L), and shall have the approximate chemical form as shown below:

<u>Constituent</u>	<u>Limit (Percent by Mass)</u>
LiNO <sub>3</sub> (Lithium Nitrate)	30 ±0.5
SO <sub>4</sub> (Sulfate Ion)	0.1 (max)
Cl (Chloride Ion)	0.2 (max)
Na (Sodium Ion)	0.1 (max)
K (Potassium Ion)	0.1 (max)

Provide a trained manufacturer’s representative to supervise the lithium nitrate admixture dispensing and mixing operations.

**501-2.11 Epoxy-resin.** All epoxy-resin materials shall be two-component materials conforming to the requirements of ASTM C881, Class as appropriate for each application temperature to be encountered, except that in addition, the materials shall meet the following requirements:

a. Material for use for embedding dowels and anchor bolts shall be Type IV, Grade 3.

b. Material for use as patching materials for complete filling of spalls and other voids and for use in preparing epoxy resin mortar shall be Type III, Grade as approved.

c. Material for use for injecting cracks shall be Type IV, Grade 1.

d. Material for bonding freshly mixed Portland cement concrete or mortar or freshly mixed epoxy resin concrete or mortar to hardened concrete shall be Type V, Grade as approved.

**501-2.12 Material acceptance.** Prior to use of materials, the Contractor shall submit certified test reports to the Engineer for those materials proposed for use during construction. The certification shall show the appropriate ASTM test for each material, the test results, and a statement that the material passed or failed.

The Engineer may request samples for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

### MIX DESIGN

**501-3.1. General.** No concrete shall be placed until the mix design has been submitted to the Engineer for review and the Engineer has taken appropriate action. The Engineer's review shall not relieve the Contractor of the responsibility to select and proportion the materials to comply with this section.

**501-3.2 Proportions.** The laboratory preparing the mix design shall be accredited in accordance with ASTM C1077. The mix design for all Portland cement concrete placed under P-501 shall be stamped or sealed by the responsible professional Engineer of the laboratory. Concrete shall be proportioned to achieve a 28-day flexural strength that meets or exceeds the acceptance criteria contained in paragraph 501-5.2 for a flexural strength of 600 psi per ASTM C78. The mix shall be developed using the procedures contained in the Portland Cement Association's (PCA) publication, "Design and Control of Concrete Mixtures".

The minimum cementitious material shall be adequate to ensure a workable, durable mix. The minimum cementitious material (cement plus fly ash, or slag cement) shall be 525 pounds per cubic yard. The ratio of water to cementitious material, including free surface moisture on the aggregates but not including moisture absorbed by the aggregates shall not be more than 0.45 no less than 0.40 by weight.

Flexural strength test specimens shall be prepared in accordance with ASTM C192 and tested in accordance with ASTM C78. The mix determined shall be workable concrete having a maximum allowable slump between one and two inches (25mm and 50 mm) as determined by ASTM C143. For slip-form concrete, the slump shall be between 1/2 inch (12 mm) and 1-1/2 inch (38 mm). At the start of the project, the Contractor shall determine a maximum allowable slump for slip-form pavement which will produce in-place pavement to control the edge slump. The selected slump shall be applicable to both pilot and fill-in lanes.

Before the start of paving operations and after approval of all material to be used in the concrete, the Contractor shall submit a mix design showing the proportions and flexural strength obtained from the concrete at seven (7) and 28 days. The mix design shall include copies of test reports, including test dates, and a complete list of materials including type, brand, source, and amount of cement, fly ash, ground slag, coarse aggregate, fine aggregate, water, and admixtures. The mix design shall be submitted to the Engineer at least 30 days prior to the start of operations. The submitted mix design shall not be more than 90 days old. Production shall not begin until the mix design is approved in writing by the Engineer.

If a change in sources is made, or admixtures added or deleted from the mix, a new mix design must be submitted to the Engineer for approval.

The results of the mix design shall include a statement giving the maximum nominal coarse aggregate size and the weights and volumes of each ingredient proportioned on a one cubic yard (meter) basis. Aggregate quantities shall be based on the mass in a saturated surface dry condition. The recommended mixture proportions shall be accompanied by test results demonstrating that the proportions selected will produce concrete of the qualities indicated. Trial mixtures having proportions, slumps, and air content suitable for the work shall be based on methodology described in PCA's publication, Design and Control of Concrete Mixtures, modified as necessary to accommodate flexural strength.

The submitted mix design shall be stamped or sealed by the responsible professional Engineer of the laboratory and shall include the following items as a minimum:

- a. Coarse, fine, and combined aggregate gradations and plots including fineness modulus of the fine aggregate.
- b. Reactivity Test Results.
- c. Coarse aggregate quality test results, including deleterious materials.
- d. Fine aggregate quality test results, including deleterious materials.
- e. Mill certificates for cement and supplemental cementitious materials.
- f. Certified test results for all admixtures, including Lithium Nitrate if applicable.
- g. Specified flexural strength, slump, and air content.
- h. Recommended proportions/volumes for proposed mixture and trial water-cementitious materials ratio, including actual slump and air content.
- i. Flexural and compressive strength summaries and plots, including all individual beam and cylinder breaks.
- j. Correlation ratios for acceptance testing and Contractor Quality Control testing, when applicable.
- k. Historical record of test results documenting production standard deviation, when applicable.

**501-3.3 Cementitious materials.**

**a. Fly ash.** When fly ash is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between 20 and 30% by weight of the total cementitious material. If fly ash is used in conjunction with slag cement the maximum replacement rate shall not exceed 10% by weight of total cementitious material.

**b. Slag cement (ground granulated blast furnace (GGBF)).** Slag cement may be used. The slag cement, or slag cement plus fly ash if both are used, may constitute between 25 to 55% of the total cementitious material by weight. If the concrete is to be used for slipforming operations and the air temperature is expected to be lower than 55°F (13°C) the percent slag cement shall not exceed 30% by weight.

**c. Raw or calcined natural pozzolan.** Natural pozzolan may be used in the mix design. When pozzolan is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between 20 and 30% by weight of the total cementitious material. If pozzolan is used in conjunction with slag cement the maximum replacement rate shall not exceed 10% by weight of total cementitious material.

**501-3.4 Admixtures.**

**a. Air-entraining admixtures.** Air-entraining admixture are to be added in such a manner that will ensure uniform distribution of the agent throughout the batch. The air content of freshly mixed air-entrained

concrete shall be based upon trial mixes with the materials to be used in the work adjusted to produce concrete of the required plasticity and workability. The percentage of air in the mix shall be 5%. Air content shall be determined by testing in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag and other highly porous coarse aggregate.

**b. Water-reducing admixtures.** Water-reducing admixtures shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements. Tests shall be conducted on trial mixes, with the materials to be used in the work, in accordance with ASTM C494.

**c. Other admixtures.** Set controlling, and other approved admixtures shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements. Tests shall be conducted on trial mixes, with the materials to be used in the work, in accordance with ASTM C 494.

**d. Lithium nitrate.** Lithium nitrate shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements in accordance with paragraph 501-2.10d.

**501-3.5 Concrete mix design laboratory.** The Contractor's laboratory used to develop the concrete mix design shall be accredited in accordance with ASTM C1077. The laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for developing the concrete mix design must be listed on the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods shall be submitted to the Engineer prior to start of construction.

## CONSTRUCTION METHODS

**501-4.1 Equipment.** Equipment necessary for handling materials and performing all parts of the work shall be approved by the Engineer, but does not relieve the Contractor of the responsibility for the proper operation of equipment and maintaining the equipment in good working condition. The equipment shall be at the jobsite sufficiently ahead of the start of paving operations to be examined thoroughly and approved.

**a. Batch plant and equipment.** The batch plant and equipment shall conform to the requirements of ASTM C94.

**b. Mixers and transportation equipment.**

**(1) General.** Concrete may be mixed at a central plant, or wholly or in part in truck mixers. Each mixer shall have attached in a prominent place a manufacturer's nameplate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades.

**(2) Central plant mixer.** Central plant mixers shall conform to the requirements of ASTM C94. The mixer shall be examined daily for changes in condition due to accumulation of hard concrete or mortar or wear of blades. The pickup and throwover blades shall be replaced when they have worn down 3/4 inch (19 mm) or more. The Contractor shall have a copy of the manufacturer's design on hand showing dimensions and arrangement of blades in reference to original height and depth.

**(3) Truck mixers and truck agitators.** Truck mixers used for mixing and hauling concrete and truck agitators used for hauling central-mixed concrete shall conform to the requirements of ASTM C94.

**(4) Nonagitator trucks.** Nonagitator hauling equipment shall conform to the requirements of ASTM C94.

**(5) Transfer and spreading equipment.** Equipment for transferring concrete from the transporting equipment to the paving lane in front of the paver shall be specially manufactured, self-propelled transfer equipment which will accept the concrete outside the paving lane and will transfer and



spread it evenly across the paving lane in front of the paver and strike off the surface evenly to a depth which permits the paver to operate efficiently.

**c. Finishing equipment.** The standard method of constructing concrete pavements shall be with an approved slip-form paving equipment designed and operated to spread, consolidate, screed, and float-finish the freshly placed concrete in one complete pass of the machine so that the end result is a dense and homogeneous pavement which is achieved with a minimum of hand finishing. The paver-finisher shall be a heavy duty, self-propelled machine designed specifically for paving and finishing high quality concrete pavements. It shall weigh at least 2,200 lbs per foot (3274 kg/m) of paving lane width and powered by an engine having at least 6.0 horsepower per foot of lane width.

On projects requiring less than 500 square yard (418 sq m) of cement concrete pavement or requiring individual placement areas of less than 500 square yard (418 sq m), or irregular areas at locations inaccessible to slip-form paving equipment, concrete pavement may be placed with approved placement and finishing equipment using stationary side forms. Hand screeding and float finishing may only be used on small irregular areas as allowed by the Engineer.

**d. Vibrators.** Vibrator shall be the internal type. Operating frequency for internal vibrators shall be between 8,000 and 12,000 vibrations per minute. Average amplitude for internal vibrators shall be 0.025-0.05 inch (0.06 - 0.13 cm).

The number, spacing, and frequency shall be as necessary to provide a dense and homogeneous pavement and meet the recommendations of American Concrete Institute (ACI) 309, Guide for Consolidation of Concrete. Adequate power to operate all vibrators shall be available on the paver. The vibrators shall be automatically controlled so that they shall be stopped as forward motion ceases. The Contractor shall provide an electronic or mechanical means to monitor vibrator status. The checks on vibrator status shall occur a minimum of two times per day or when requested by the Engineer.

Hand held vibrators may be used in irregular areas only, but shall meet the recommendations of ACI 309R, Guide for Consolidation of Concrete.

**e. Concrete saws.** The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions. The Contractor shall provide at least one standby saw in good working order and a supply of saw blades at the site of the work at all times during sawing operations. Early-entry saws may be used, subject to demonstration and approval of the Engineer.

**f. Side forms.** Straight side forms shall be made of steel and shall be furnished in sections not less than 10 feet (3 m) in length. Forms shall have a depth equal to the pavement thickness at the edge, and a base width equal to or greater than the depth. Flexible or curved forms of proper radius shall be used for curves of 100-foot (31 m) radius or less. Forms shall be provided with adequate devices for secure settings so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms with battered top surfaces and bent, twisted or broken forms shall not be used. Built-up forms shall not be used, except as approved by the Engineer. The top face of the form shall not vary from a true plane more than 1/8 inch (3 mm) in 10 feet (3 m), and the upstanding leg shall not vary more than 1/4 inch (6 mm). The forms shall contain provisions for locking the ends of abutting sections together tightly for secure setting. Wood forms may be used under special conditions, when approved by the Engineer.

**g. Pavers.** The paver shall be fully energized, self-propelled, and designed for the specific purpose of placing, consolidating, and finishing the concrete pavement, true to grade, tolerances, and cross-section. It shall be of sufficient weight and power to construct the maximum specified concrete paving lane width as shown in the plans, at adequate forward speed, without transverse, longitudinal or vertical instability or without displacement. The paver shall be equipped with electronic or hydraulic horizontal and vertical control devices.

**501-4.2 Form setting.** Forms shall be set sufficiently in advance of the concrete placement to ensure continuous paving operation. After the forms have been set to correct grade, the underlying surface shall be thoroughly tamped, either mechanically or by hand, at both the inside and outside edges of the base of the forms. Forms shall be staked into place sufficiently to maintain the form in position for the method of placement.

Form sections shall be tightly locked and shall be free from play or movement in any direction. The forms shall not deviate from true line by more than 1/8 inch (3 mm) at any joint. Forms shall be so set that they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms shall be cleaned and oiled prior to the placing of concrete.

The alignment and grade elevations of the forms shall be checked and corrections made by the Contractor immediately before placing the concrete.

**501-4.3 Conditioning of underlying surface.** The compacted underlying surface on which the pavement will be placed shall be widened approximately 3 feet (1 m) to extend beyond the paving machine track to support the paver without any noticeable displacement. After the underlying surface has been placed and compacted to the required density, the areas that will support the paving machine and the area to be paved shall be trimmed or graded to the plan grade elevation and profile by means of a properly designed machine. The grade of the underlying surface shall be controlled by a positive grade control system using lasers, stringlines, or guide wires. If the density of the underlying surface is disturbed by the trimming operations, it shall be corrected by additional compaction and retested at the option of the Engineer before the concrete is placed except when stabilized subbases are being constructed. If damage occurs on a stabilized subbase, it shall be corrected full depth by the Contractor. If traffic is allowed to use the prepared grade, the grade shall be checked and corrected immediately before the placement of concrete. The prepared grade shall be moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from concrete. The underlying surface shall be protected so that it will be entirely free of frost when concrete is placed.

**501-4.4 Conditioning of underlying surface, side-form and fill-in lane construction.** The prepared underlying surface shall be moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from the concrete. Damage caused by hauling or usage of other equipment shall be corrected and retested at the option of the Engineers. If damage occurs to a stabilized subbase, it shall be corrected full depth by the Contractor. A template shall be provided and operated on the forms immediately in advance of the placing of all concrete. The template shall be propelled only by hand and not attached to a tractor or other power unit. Templates shall be adjustable so that they may be set and maintained at the correct contour of the underlying surface. The adjustment and operation of the templates shall be such as will provide an accurate retest of the grade before placing the concrete thereon. All excess material shall be removed and wasted. Low areas shall be filled and compacted to a condition similar to that of the surrounding grade. The underlying surface shall be protected so that it will be entirely free from frost when the concrete is placed. The use of chemicals to eliminate frost in the underlying surface shall not be permitted.

The template shall be maintained in accurate adjustment, at all times by the Contractor, and shall be checked daily.

**501-4.5 Handling, measuring, and batching material.** The batch plant site, layout, equipment, and provisions for transporting material shall assure a continuous supply of material to the work. Stockpiles shall be constructed in such a manner that prevents segregation and intermixing of deleterious materials. Aggregates from different sources shall be stockpiled, weighed and batched separately at the concrete batch plant.

Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned

for draining at least 12 hours before being batched. Rail shipments requiring more than 12 hours will be accepted as adequate binning only if the car bodies permit free drainage.

Batching plants shall be equipped to proportion aggregates and bulk cement, by weight, automatically using interlocked proportioning devices of an approved type. When bulk cement is used, the Contractor shall use a suitable method of handling the cement from weighing hopper to transporting container or into the batch itself for transportation to the mixer, such as a chute, boot, or other approved device, to prevent loss of cement. The device shall be arranged to provide positive assurance that the cement content specified is present in each batch.

**501-4.6 Mixing concrete.** The concrete may be mixed at the work site, in a central mix plant or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials, except water, are emptied into the drum. All concrete shall be mixed and delivered to the site in accordance with the requirements of ASTM C94.

Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or non-agitating trucks. The elapsed time from the addition of cementitious material to the mix until the concrete is deposited in place at the work site shall not exceed 30 minutes when the concrete is hauled in non-agitating trucks, nor 90 minutes when the concrete is hauled in truck mixers or truck agitators. Retempering concrete by adding water or by other means will not be permitted. With transit mixers additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements provided the addition of water is performed within 45 minutes after the initial mixing operations and provided the water/cementitious ratio specified in the approved mix design is not exceeded, and approved by the Engineer.

**501-4.7 Limitations on mixing and placing.** No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

**a. Cold weather.** Unless authorized in writing by the Engineer, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40°F (4°C) and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F (2°C).

The aggregate shall be free of ice, snow, and frozen lumps before entering the mixer. The temperature of the mixed concrete shall not be less than 50°F (10°C) at the time of placement. Concrete shall not be placed on frozen material nor shall frozen aggregates be used in the concrete.

When concreting is authorized during cold weather, water and/or the aggregates may be heated to not more than 150°F (66°C). The apparatus used shall heat the mass uniformly and shall be arranged to preclude the possible occurrence of overheated areas which might be detrimental to the materials.

**b. Hot weather.** During periods of hot weather when the maximum daily air temperature exceeds 85°F (30°C), the following precautions shall be taken.

The forms and/or the underlying surface shall be sprinkled with water immediately before placing the concrete. The concrete shall be placed at the coolest temperature practicable, and in no case shall the temperature of the concrete when placed exceed 90°F (32°C). The aggregates and/or mixing water shall be cooled as necessary to maintain the concrete temperature at or not more than the specified maximum.

The finished surfaces of the newly laid pavement shall be kept damp by applying a water-fog or mist with approved spraying equipment until the pavement is covered by the curing medium. When necessary, wind screens shall be provided to protect the concrete from an evaporation rate in excess of 0.2 psf (0.98 kg/m<sup>2</sup> per hour) per hour. When conditions are such that problems with plastic cracking can be expected, and particularly if any plastic cracking begins to occur, the Contractor shall immediately take such additional measures as necessary to protect the concrete surface. Such measures shall consist of wind

screens, more effective fog sprays, and similar measures commencing immediately behind the paver. If these measures are not effective in preventing plastic cracking, paving operations shall be immediately stopped.

**c. Temperature management program.** Prior to the start of paving operation for each day of paving, the Contractor shall provide the Engineer with a Temperature Management Program for the concrete to be placed to assure that uncontrolled cracking is avoided. As a minimum the program shall address the following items:

(1) Anticipated tensile strains in the fresh concrete as related to heating and cooling of the concrete material.

(2) Anticipated weather conditions such as ambient temperatures, wind velocity, and relative humidity; and anticipated evaporation rate using Figure 11-8, PCA, Design and Control of Concrete Mixtures.

(3) Anticipated timing of initial sawing of joint.

(4) Anticipated number and type of saws to be used.

**501-4.8 Placing concrete.** At any point in concrete conveyance, the free vertical drop of the concrete from one point to another or to the underlying surface shall not exceed 3 feet (1 m). The finished concrete product must be dense and homogeneous, without segregation and conforming to the standards in this specification. Backhoes and grading equipment shall not be used to distribute the concrete in front of the paver. Front end loaders will not be used. All concrete shall be consolidated without voids or segregation, including under and around all load-transfer devices, joint assembly units, and other features embedded in the pavement. Hauling equipment or other mechanical equipment can be permitted on adjoining previously constructed pavement when the concrete strength reaches a flexural strength of 550 psi, based on the average of four field cured specimens per 2,000 cubic yards (1,530 cubic meters) of concrete placed. Also, subgrade and subbase planers, concrete pavers, and concrete finishing equipment may be permitted to ride upon the edges of previously constructed pavement when the concrete has attained a minimum flexural strength of 400 psi.

The Contractor shall have available materials for the protection of the concrete during inclement weather. Such protective materials shall consist of rolled polyethylene sheeting at least 4 mils (0.1 mm) thick of sufficient length and width to cover the plastic concrete slab and any edges. The sheeting may be mounted on either the paver or a separate movable bridge from which it can be unrolled without dragging over the plastic concrete surface. When rain appears imminent, all paving operations shall stop and all available personnel shall begin covering the surface of the unhardened concrete with the protective covering.

**a. Slip-form construction.** The concrete shall be distributed uniformly into final position by a self-propelled slip-form paver without delay. The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose. The paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed and the vibration shall be adequate to provide a consistency of concrete that will stand normal to the surface with sharp well defined edges. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The plastic concrete shall be effectively consolidated by internal vibration with transverse vibrating units for the full width of the pavement and/or a series of equally placed longitudinal vibrating units. The space from the outer edge of the pavement to longitudinal unit shall not exceed 9 inches (23 cm) for slipform and at the end of the dowels for the fill-in lanes. The spacing of internal units shall be uniform and shall not exceed 18 inches (0.5 m).

The term internal vibration means vibrating units located within the specified thickness of pavement section.

The rate of vibration of each vibrating unit shall be within 8000 to 12000 cycles per minute and the amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete along the entire length of the vibrating unit and for a distance of at least one foot (30 cm). The frequency of vibration or

amplitude shall vary proportionately with the rate of travel to result in a uniform density and air content. The paving machine shall be equipped with a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

The concrete shall be held at a uniform consistency. The slip-form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be coordinated to provide uniform progress with stopping and starting of the paver held to a minimum. If for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels on which the bearing surface is offset to run a sufficient distance from the edge of the pavement to avoid breaking the pavement edge.

Not more than 15% of the total free edge of each 500 foot (150 m) segment of pavement, or fraction thereof, shall have an edge slump exceeding 1/4 inch (6 mm), and none of the free edge of the pavement shall have an edge slump exceeding 3/8 inch (9 mm). (The total free edge of 500 feet (150 m) of pavement will be considered the cumulative total linear measurement of pavement edge originally constructed as nonadjacent to any existing pavement; that is, 500 feet (150 m) of paving lane originally constructed as a separate lane will have 1,000 feet (300 m) of free edge, 500 feet (150 m) of fill-in lane will have no free edge, etc.). The area affected by the downward movement of the concrete along the pavement edge shall be limited to not more than 18 inches (0.5 m) from the edge. When excessive edge slump cannot be corrected before the concrete has hardened, the area with excessive edge slump shall be removed and replaced at the expense of the Contractor as directed by the Engineer.

**b. Side-form construction.** Side form sections shall be straight, free from warps, bends, indentations, or other defects. Defective forms shall be removed from the work. Metal side forms shall be used except at end closures and transverse construction joints where straight forms of other suitable material may be used.

Side forms may be built up by rigidly attaching a section to either top or bottom of forms. If such build-up is attached to the top of metal forms, the build-up shall also be metal.

Width of the base of all forms shall be equal to or greater than the specified pavement thickness.

Side forms shall be of sufficient rigidity, both in the form and in the interlocking connection with adjoining forms, that springing will not occur under the weight of subgrading and paving equipment or from the pressure of the concrete. The Contractor shall provide sufficient forms so that there will be no delay in placing concrete due to lack of forms.

Before placing side forms, the underlying material shall be at the proper grade. Side forms shall have full bearing upon the foundation throughout their length and width of base and shall be placed to the required grade and alignment of the finished pavement. They shall be firmly supported during the entire operation of placing, compacting, and finishing the pavement.

Forms shall be drilled in advance of being placed to line and grade to accommodate tie bars where these are specified.

Immediately in advance of placing concrete and after all subbase operations are completed, side forms shall be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing.

Side forms shall remain in place at least 12 hours after the concrete has been placed, and in all cases until the edge of the pavement no longer requires the protection of the forms. Curing compound shall be applied to the concrete immediately after the forms have been removed.

Side forms shall be thoroughly cleaned and oiled each time they are used and before concrete is placed against them.

Concrete shall be spread, screeded, shaped and consolidated by one or more self-propelled machines. These machines shall uniformly distribute and consolidate concrete without segregation so that the completed pavement will conform to the required cross-section with a minimum of handwork.

The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to that of concrete delivery.

Concrete for the full paving width shall be effectively consolidated by internal vibrators without causing segregation. Internal type vibrators' rate of vibration shall be not less than 7,000 cycles per minute. Amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete more than one foot (30 cm) from the vibrating element. The Contractor shall furnish a tachometer or other suitable device for measuring and indicating frequency of vibration.

Power to vibrators shall be connected so that vibration ceases when forward or backward motion of the machine is stopped.

The provisions relating to the frequency and amplitude of internal vibration shall be considered the minimum requirements and are intended to ensure adequate density in the hardened concrete.

**c. Consolidation.** Concrete shall be consolidated with the specified type of lane-spanning, gang-mounted, mechanical, immersion type vibrating equipment mounted in front of the paver, supplemented, in rare instances as specified, by hand-operated vibrators. The vibrators shall be inserted into the concrete to a depth that will provide the best full-depth consolidation but not closer to the underlying material than inches (50 mm). Excessive vibration shall not be permitted. If the vibrators cause visible tracking in the paving lane, the paving operation shall be stopped and equipment and operations modified to prevent it. Concrete in small, odd-shaped slabs or in isolated locations inaccessible to the gang-mounted vibration equipment shall be vibrated with an approved hand-operated immersion vibrator operated from a bridge spanning the area. Vibrators shall not be used to transport or spread the concrete. Hand-operated vibrators shall not be operated in the concrete at one location for more than 20 seconds. Insertion locations for hand-operated vibrators shall be between 6 to 15 inches (150 to 400 mm) on centers. For each paving train, at least one additional vibrator spud, or sufficient parts for rapid replacement and repair of vibrators shall be maintained at the paving site at all times. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) shall require the immediate stopping of the paving operation and adjustment of the equipment or procedures as approved by the Engineer.

If a lack of consolidation of the concrete is suspected by the Engineer, referee testing may be required. Referee testing of hardened concrete will be performed by the Engineer by cutting cores from the finished pavement after a minimum of 24 hours curing. Density determinations will be made by the Engineer based on the water content of the core as taken. ASTM C642 shall be used for the determination of core density in the saturated-surface dry condition. When required, referee cores will be taken at the minimum rate of one for each 500 cubic yards (382 m<sup>2</sup>) of pavement, or fraction. The Contractor shall be responsible for all referee testing cost if they fail to meet the required density.

The average density of the cores shall be at least 97% of the original mix design density, with no cores having a density of less than 96% of the original mix design density. Failure to meet the referee tests will be considered evidence that the minimum requirements for vibration are inadequate for the job conditions. Additional vibrating units or other means of increasing the effect of vibration shall be employed so that the density of the hardened concrete conforms to the above requirements.

**501-4.9 Strike-off of concrete and placement of reinforcement.** Following the placing of the concrete, it shall be struck off to conform to the cross-section shown on the plans and to an elevation that when the concrete is properly consolidated and finished, the surface of the pavement shall be at the elevation shown

on the plans. When reinforced concrete pavement is placed in two layers, the bottom layer shall be struck off to such length and depth that the sheet of reinforcing steel fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed directly upon the concrete, after which the top layer of the concrete shall be placed, struck off, and screeded. If any portion of the bottom layer of concrete has been placed more than 30 minutes without being covered with the top layer or if initial set has taken place, it shall be removed and replaced with freshly mixed concrete at the Contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be positioned in advance of concrete placement or it may be placed in plastic concrete by mechanical or vibratory means after spreading.

Reinforcing steel, at the time concrete is placed, shall be free of mud, oil, or other organic matter that may adversely affect or reduce bond. Reinforcing steel with rust, mill scale or a combination of both will be considered satisfactory, provided the minimum dimensions, weight, and tensile properties of a hand wire-brushed test specimen are not less than the applicable ASTM specification requirements.

**501-4.10 Joints.** Joints shall be constructed as shown on the plans and in accordance with these requirements. All joints shall be constructed with their faces perpendicular to the surface of the pavement and finished or edged as shown on the plans. Joints shall not vary more than 1/2 inch (12 mm) from their designated position and shall be true to line with not more than 1/4 inch (6 mm) variation in 10 feet (3 m). The surface across the joints shall be tested with a 12 feet (3 m) straightedge as the joints are finished and any irregularities in excess of 1/4 inch (6 mm) shall be corrected before the concrete has hardened. All joints shall be so prepared, finished, or cut to provide a groove of uniform width and depth as shown on the plans.

**a. Construction.** Longitudinal construction joints shall be slip-formed or formed against side forms as shown in the plans.

Transverse construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for more than 30 minutes or it appears that the concrete will obtain its initial set before fresh concrete arrives. The installation of the joint shall be located at a planned contraction or expansion joint. If placing of the concrete is stopped, the Contractor shall remove the excess concrete back to the previous planned joint.

**b. Contraction.** Contraction joints shall be installed at the locations and spacing as shown on the plans. Contraction joints shall be installed to the dimensions required by forming a groove or cleft in the top of the slab while the concrete is still plastic or by sawing a groove into the concrete surface after the concrete has hardened. When the groove is formed in plastic concrete the sides of the grooves shall be finished even and smooth with an edging tool. If an insert material is used, the installation and edge finish shall be according to the manufacturer's instructions. The groove shall be finished or cut clean so that spalling will be avoided at intersections with other joints. Grooving or sawing shall produce a slot at least 1/8 inch (3 mm) wide and to the depth shown on the plans.

**c. Isolation (expansion).** Isolation joints shall be installed as shown on the plans. The premolded filler of the thickness as shown on the plans, shall extend for the full depth and width of the slab at the joint, except for space for sealant at the top of the slab. The filler shall be securely staked or fastened into position perpendicular to the proposed finished surface. A cap shall be provided to protect the top edge of the filler and to permit the concrete to be placed and finished. After the concrete has been placed and struck off, the cap shall be carefully withdrawn leaving the space over the premolded filler. The edges of the joint shall be finished and tooled while the concrete is still plastic. Any concrete bridging the joint space shall be removed for the full width and depth of the joint.

**d. Tie bars.** Tie bars shall consist of deformed bars installed in joints as shown on the plans. Tie bars shall be placed at right angles to the centerline of the concrete slab and shall be spaced at intervals shown on the plans. They shall be held in position parallel to the pavement surface and in the middle of the slab

depth. When tie bars extend into an unpaved lane, they may be bent against the form at longitudinal construction joints, unless threaded bolt or other assembled tie bars are specified. Tie bars shall not be painted, greased, or enclosed in sleeves. When slip-form operations call for tie bars, two-piece hook bolts can be installed.

**e. Dowel bars.** Dowel bars or other load-transfer units of an approved type shall be placed across joints as shown on the plans. They shall be of the dimensions and spacings as shown and held rigidly in the middle of the slab depth in the proper horizontal and vertical alignment by an approved assembly device to be left permanently in place. The dowel or load-transfer and joint devices shall be rigid enough to permit complete assembly as a unit ready to be lifted and placed into position. The dowels shall be coated with a bond-breaker or other lubricant recommended by the manufacturer and approved by the Engineer.

**f.** Dowels bars at longitudinal construction joints shall be bonded in drilled holes.

**g. Placing dowels and tie bars.** The method used in installing and holding dowels in position shall ensure that the error in alignment of any dowel from its required horizontal and vertical alignment after the pavement has been completed will not be greater than 1/8 inch per feet (3 mm per 0.3 m). Except as otherwise specified below, horizontal spacing of dowels shall be within a tolerance of  $\pm 5/8$  inch (16 mm). The vertical location on the face of the slab shall be within a tolerance of  $\pm 1/2$  inch (12 mm). The vertical alignment of the dowels shall be measured parallel to the designated top surface of the pavement, except for those across the crown or other grade change joints. Dowels across crowns and other joints at grade changes shall be measured to a level surface. Horizontal alignment shall be checked perpendicular to the joint edge. The horizontal alignment shall be checked with a framing square. Dowels bars shall not be placed closer than 0.6 times the dowel bar length to the planned joint line. If the last regularly spaced longitudinal dowel is closer than that dimension, it shall be moved away from the joint to a location 0.6 times the dowel bar length, but not closer than 6 inches (150 mm) to its nearest neighbor. The portion of each dowel intended to move within the concrete or expansion cap shall be wiped clean and coated with a thin, even film of lubricating oil or light grease before the concrete is placed. Dowels shall be installed as specified in the following subparagraphs.

**(1) Contraction joints.** Dowels and tie bars in longitudinal and transverse contraction joints within the paving lane shall be held securely in place, as indicated, by means of rigid metal frames or basket assemblies of an approved type. The basket assemblies shall be held securely in the proper location by means of suitable pins or anchors. Do not cut or crimp the dowel basket tie wires. At the Contractor's option, in lieu of the above, dowels and tie bars in contraction joints shall be installed near the front of the paver by insertion into the plastic concrete using approved equipment and procedures. Approval will be based on the results of a preconstruction demonstration, showing that the dowels and tie bars are installed within specified tolerances.

**(2) Construction joints.** Install dowels and tie bars by the cast-in- place or the drill-and-dowel method. Installation by removing and replacing in preformed holes will not be permitted. Dowels and tie bars shall be prepared and placed across joints where indicated, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms. The spacing of dowels and tie bars in construction joints shall be as indicated.

**(3) Dowels installed in isolation joints and other hardened concrete.** Install dowels for isolation joints and in other hardened concrete by bonding the dowels into holes drilled into the hardened concrete. The concrete shall have cured for seven (7) days or reached a minimum flexural strength of 450 psi before drilling commences. Holes 1/8 inch (3 mm) greater in diameter than the dowels shall be drilled into the hardened concrete using rotary-core drills. Rotary-percussion drills may be used, provided that excessive spalling does not occur to the concrete joint face. Modification of the equipment and operation shall be required if, in the Engineer's opinion, the equipment and/or operation is causing excessive damage. Depth of dowel hole shall be within a tolerance of  $\pm 1/2$  inch (12 mm) of the dimension shown on the drawings. On completion of the drilling operation, the dowel hole shall be blown out with oil-free, compressed air.



Dowels shall be bonded in the drilled holes using epoxy resin. Epoxy resin shall be injected at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel will not be permitted. The dowels shall be held in alignment at the collar of the hole, after insertion and before the grout hardens, by means of a suitable metal or plastic grout retention ring fitted around the dowel. Dowels required to be installed in any joints between new and existing concrete shall be grouted in holes drilled in the existing concrete, all as specified above.

**h. Sawing of joints.** Joints shall be cut as shown on the plans. Equipment shall be as described in paragraph 501-4.1. The circular cutter shall be capable of cutting a groove in a straight line and shall produce a slot at least 1/8 inch (3 mm) wide and to the depth shown on the plans. The top of the slot shall be widened by sawing to provide adequate space for joint sealers as shown on the plans. Sawing shall commence, without regard to day or night, as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling, or tearing and before uncontrolled shrinkage cracking of the pavement occurs and shall continue without interruption until all joints have been sawn. The joints shall be sawn at the required spacing. All slurry and debris produced in the sawing of joints shall be removed by vacuuming and washing. Curing compound or system shall be reapplied in the initial sawcut and maintained for the remaining cure period.

**501-4.11 Finishing.** Finishing operations shall be a continuing part of placing operations starting immediately behind the strike-off of the paver. Initial finishing shall be provided by the transverse screed or extrusion plate. The sequence of operations shall be transverse finishing, longitudinal machine floating if used, straightedge finishing, texturing, and then edging of joints. Finishing shall be by the machine method. The hand method shall be used only on isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. Supplemental hand finishing for machine finished pavement shall be kept to an absolute minimum. Any machine finishing operation which requires appreciable hand finishing, other than a moderate amount of straightedge finishing, shall be immediately stopped and proper adjustments made or the equipment replaced. Any operations which produce more than 1/8 inch (3 mm) of mortar-rich surface (defined as deficient in plus U.S. No. 4 (4.75 mm) sieve size aggregate) shall be halted immediately and the equipment, mixture, or procedures modified as necessary. Compensation shall be made for surging behind the screeds or extrusion plate and settlement during hardening and care shall be taken to ensure that paving and finishing machines are properly adjusted so that the finished surface of the concrete (not just the cutting edges of the screeds) will be at the required line and grade. Finishing equipment and tools shall be maintained clean and in an approved condition. At no time shall water be added to the surface of the slab with the finishing equipment or tools, or in any other way, except for fog (mist) sprays specified to prevent plastic shrinkage cracking.

**a. Machine finishing with slipform pavers.** The slipform paver shall be operated so that only a very minimum of additional finishing work is required to produce pavement surfaces and edges meeting the specified tolerances. Any equipment or procedure that fails to meet these specified requirements shall immediately be replaced or modified as necessary. A self-propelled non-rotating pipe float may be used while the concrete is still plastic, to remove minor irregularities and score marks. Only one pass of the pipe float shall be allowed. If there is concrete slurry or fluid paste on the surface that runs over the edge of the pavement, the paving operation shall be immediately stopped and the equipment, mixture, or operation modified to prevent formation of such slurry. Any slurry which does run down the vertical edges shall be immediately removed by hand, using stiff brushes or scrapers. No slurry, concrete or concrete mortar shall be used to build up along the edges of the pavement to compensate for excessive edge slump, either while the concrete is plastic or after it hardens.

**b. Machine finishing with fixed forms.** The machine shall be designed to straddle the forms and shall be operated to screed and consolidate the concrete. Machines that cause displacement of the forms shall be replaced. The machine shall make only one pass over each area of pavement. If the equipment and

procedures do not produce a surface of uniform texture, true to grade, in one pass, the operation shall be immediately stopped and the equipment, mixture, and procedures adjusted as necessary.

**c. Other types of finishing equipment.** Clary screeds, other rotating tube floats, or bridge deck finishers are not allowed on mainline paving, but may be allowed on irregular or odd-shaped slabs, and near buildings or trench drains, subject to the Engineer's approval.

Bridge deck finishers shall have a minimum operating weight of 7500 pounds (3400 kg) and shall have a transversely operating carriage containing a knock-down auger and a minimum of two immersion vibrators. Vibrating screeds or pans shall be used only for isolated slabs where hand finishing is permitted as specified, and only where specifically approved.

**d. Hand finishing.** Hand finishing methods will not be permitted, except under the following conditions: (1) in the event of breakdown of the mechanical equipment, hand methods may be used to finish the concrete already deposited on the grade and (2) in areas of narrow widths or of irregular dimensions where operation of the mechanical equipment is impractical. Use hand finishing operations only as specified below.

**(1) Equipment and screed.** In addition to approved mechanical internal vibrators for consolidating the concrete, provide a strike-off and tamping screed and a longitudinal float for hand finishing. The screed shall be at least one foot (30 cm) longer than the width of pavement being finished, of an approved design, and sufficiently rigid to retain its shape, and shall be constructed of metal or other suitable material shod with metal. The longitudinal float shall be at least 10 feet (3 m) long, of approved design, and rigid and substantially braced, and shall maintain a plane surface on the bottom. Grate tampers (jitterbugs) shall not be used.

**(2) Finishing and floating.** As soon as placed and vibrated, the concrete shall be struck off and screeded to the crown and cross-section and to such elevation above grade that when consolidated and finished, the surface of the pavement will be at the required elevation. In addition to previously specified complete coverage with handheld immersion vibrators, the entire surface shall be tamped with the strike-off and tamping template, and the tamping operation continued until the required compaction and reduction of internal and surface voids are accomplished. Immediately following the final tamping of the surface, the pavement shall be floated longitudinally from bridges resting on the side forms and spanning but not touching the concrete. If necessary, additional concrete shall be placed, consolidated and screeded, and the float operated until a satisfactory surface has been produced. The floating operation shall be advanced not more than half the length of the float and then continued over the new and previously floated surfaces.

**e. Straightedge testing and surface correction.** After the pavement has been struck off and while the concrete is still plastic, it shall be tested for trueness with a Contractor furnished 12-foot (3.7-m) straightedge swung from handles 3 feet (1 m) longer than one-half the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the centerline and the whole area gone over from one side of the slab to the other, as necessary. Advancing shall be in successive stages of not more than one-half the length of the straightedge. Any excess water and laitance in excess of 1/8 inch (3 mm) thick shall be removed from the surface of the pavement and wasted. Any depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the smoothness requirements of paragraph 501-5.2e(3). Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and until the slab conforms to the required grade and cross-section. The use of long-handled wood floats shall be confined to a minimum; they may be used only in emergencies and in areas not accessible to finishing equipment. This straight-edging is not a replacement for the straightedge testing of paragraph 501-5.2e(3), Smoothness.

**501-4.12 Surface texture.** The surface of the pavement shall be finished with either a brush or broom, burlap drag, or artificial turf finish for all newly constructed concrete pavements. It is important that the texturing equipment not tear or unduly roughen the pavement surface during the operation. Any imperfections resulting from the texturing operation shall be corrected to the satisfaction of the Engineer.

**a. Brush or broom finish.** If the pavement surface texture is to be a type of brush or broom finish, it shall be applied when the water sheen has practically disappeared. The equipment shall operate transversely across the pavement surface, providing corrugations that are uniform in appearance and approximately 1/16 inch (2 mm) in depth.

**501-4.13 Curing.** Immediately after finishing operations are completed and marring of the concrete will not occur, the entire surface of the newly placed concrete shall be cured for a 7-day cure period in accordance with one of the methods below. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 hour during the curing period.

When a two-sawcut method is used to construct the contraction joint, the curing compound shall be applied to the sawcut immediately after the initial cut has been made. The sealant reservoir shall not be sawed until after the curing period has been completed. When the one cut method is used to construct the contraction joint, the joint shall be cured with wet rope, wet rags, or wet blankets. The rags, ropes, or blankets shall be kept moist for the duration of the curing period.

**a. Impervious membrane method.** The entire surface of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place. The curing compound shall not be applied during rainfall. Curing compound shall be applied by mechanical sprayers under pressure at the rate of one gallon (4 liters) to not more than 150 sq ft (14 sq m). The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application the compound shall be stirred continuously by mechanical means. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted. When hand spraying is approved by the Engineer, a double application rate shall be used to ensure coverage. The curing compound shall be of such character that the film will harden within 30 minutes after application. Should the film become damaged from any cause, including sawing operations, within the required curing period, the damaged portions shall be repaired immediately with additional compound or other approved means. Upon removal of side forms, the sides of the exposed slabs shall be protected immediately to provide a curing treatment equal to that provided for the surface. Curing shall be applied immediately after the bleed water is gone from the surface.

**b. White burlap-polyethylene sheets.** The surface of the pavement shall be entirely covered with the sheeting. The sheeting used shall be such length (or width) that it will extend at least twice the thickness of the pavement beyond the edges of the slab. The sheeting shall be placed so that the entire surface and both edges of the slab are completely covered. The sheeting shall be placed and weighted to remain in contact with the surface covered, and the covering shall be maintained fully saturated and in position for seven (7) days after the concrete has been placed.

**c. Water method.** The entire area shall be covered with burlap or other water absorbing material. The material shall be of sufficient thickness to retain water for adequate curing without excessive runoff. The material shall be kept wet at all times and maintained for seven (7) days. When the forms are stripped, the vertical walls shall also be kept moist. It shall be the responsibility of the Contractor to prevent ponding of the curing water on the subbase.

**d. Concrete protection for cold weather.** The concrete shall be maintained at an ambient temperature of at least 50°F (10°C) for a period of 72 hours after placing and at a temperature above freezing for the

remainder of the curing time. The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather; and any concrete damaged shall be removed and replaced at the Contractor's expense.

**e. Concrete protection for hot weather.** Concrete should be continuously moisture cured for the entire curing period and shall commence as soon as the surfaces are finished and continue for at least 24 hours. However, if moisture curing is not practical beyond 24 hours, the concrete surface shall be protected from drying with application of a liquid membrane-forming curing compound while the surfaces are still damp. Other curing methods may be approved by the Engineer.

**501-4.14 Removing forms.** Unless otherwise specified, forms shall not be removed from freshly placed concrete until it has hardened sufficiently to permit removal without chipping, spalling, or tearing. After the forms have been removed, the sides of the slab shall be cured as per the methods indicated in paragraph 501-4.13. Major honeycombed areas shall be considered as defective work and shall be removed and replaced in accordance with paragraph 501-5.2(f).

**501-4.15 Saw-cut grooving.** If shown on the plans, grooved surfaces shall be provided in accordance with the requirements of Item P-621.

**501-4.16 Sealing joints.** The joints in the pavement shall be sealed in accordance with Item P-605.

**501-4.17 Protection of pavement.** The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by the Contractor's employees and agents until accepted by the Engineer. This shall include watchmen to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, crossovers, and protection of unsealed joints from intrusion of foreign material, etc. Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement replaced at the Contractor's expense.

Aggregates, rubble, or other similar construction materials shall not be placed on airfield pavements. Traffic shall be excluded from the new pavement by erecting and maintaining barricades and signs until the concrete is at least seven (7) days old, or for a longer period if directed by the Engineer.

In paving intermediate lanes between newly paved pilot lanes, operation of the hauling and paving equipment will be permitted on the new pavement after the pavement has been cured for seven (7) days and the joints have been sealed or otherwise protected, and the concrete has attained a minimum field cured flexural strength of 550 psi (37928 kPa) and approved means are furnished to prevent damage to the slab edge.

All new and existing pavement carrying construction traffic or equipment shall be continuously kept completely clean, and spillage of concrete or other materials shall be cleaned up immediately upon occurrence.

Damaged pavements shall be removed and replaced at the Contractor's expense. Slabs shall be removed to the full depth, width, and length of the slab.

**501-4.18 Opening to construction traffic.** The pavement shall not be opened to traffic until test specimens molded and cured in accordance with ASTM C31 have attained a flexural strength of 550 lb / square inch (3.8 kPa) when tested in accordance with ASTM C78. If such tests are not conducted, the pavement shall not be opened to traffic until 14 days after the concrete was placed. Prior to opening the pavement to construction traffic, all joints shall either be sealed or protected from damage to the joint edge and intrusion of foreign materials into the joint. As a minimum, backer rod or tape may be used to protect the joints from foreign matter intrusion.

**501-4.19 Repair, removal, or replacement of slabs.**

**a. General.** New pavement slabs that are broken or contain cracks or are otherwise defective or unacceptable shall be removed and replaced or repaired, as directed by the Engineer and as specified hereinafter at no cost to the Owner. Spalls along joints shall be repaired as specified. Removal of partial slabs is not permitted. Removal and replacement shall be full depth, shall be full width of the slab, and the limit of removal shall be normal to the paving lane and to each original transverse joint. The Engineer will determine whether cracks extend full depth of the pavement and may require cores to be drilled on the crack to determine depth of cracking. Such cores shall be 4 inch (100 mm) diameter, shall be drilled by the Contractor and shall be filled by the Contractor with a well consolidated concrete mixture bonded to the walls of the hole with epoxy resin, using approved procedures. Drilling of cores and refilling holes shall be at no expense to the Owner. All epoxy resin used in this work shall conform to ASTM C881, Type V. Repair of cracks as described in this section shall not be allowed if in the opinion of the Engineer the overall condition of the pavement indicates that such repair is unlikely to achieve an acceptable and durable finished pavement. No repair of cracks shall be allowed in any panel that demonstrates segregated aggregate with an absence of coarse aggregate in the upper 1/8 inch (3 mm) of the pavement surface.

**b. Shrinkage cracks.** Shrinkage cracks, which do not exceed 4 inches (100 mm) in depth, shall be cleaned and then pressure injected with epoxy resin, Type IV, Grade 1, using procedures as approved by the Engineer. Care shall be taken to assure that the crack is not widened during epoxy resin injection. All epoxy resin injection shall take place in the presence of the Engineer. Shrinkage cracks, which exceed 4 inches (100 mm) in depth, shall be treated as full depth cracks in accordance with paragraphs 4.19b and 4.19c.

**c. Slabs with cracks through interior areas.** Interior area is defined as that area more than 6 inches (150 mm) from either adjacent original transverse joint. The full slab shall be removed and replaced at no cost to the Owner, when there are any full depth cracks, or cracks greater than 4 inches (100 mm) in depth, that extend into the interior area.

**d. Cracks close to and parallel to joints.** All cracks essentially parallel to original joints, extending full depth of the slab, and lying wholly within 6 inches (150 mm) either side of the joint shall be treated as specified here. Any crack extending more than 6 inches (150 mm) from the joint shall be treated as specified above in subparagraph c.

**(1) Full depth cracks present, original joint not opened.** When the original un-cracked joint has not opened, the crack shall be sawed and sealed, and the original joint filled with epoxy resin as specified below. The crack shall be sawed with equipment specially designed to follow random cracks. The reservoir for joint sealant in the crack shall be formed by sawing to a depth of 3/4 inches (19 mm),  $\pm 1/16$  inch (2 mm), and to a width of 5/8 inch (16 mm),  $\pm 1/8$  inch (3 mm). Any equipment or procedure which causes raveling or spalling along the crack shall be modified or replaced to prevent such raveling or spalling. The joint sealant shall be a liquid sealant as specified. Installation of joint seal shall be as specified for sealing joints or as directed. If the joint sealant reservoir has been sawed out, the reservoir and as much of the lower saw cut as possible shall be filled with epoxy resin, Type IV, Grade 2, thoroughly tooled into the void using approved procedures.

If only the original narrow saw cut has been made, it shall be cleaned and pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures. If filler type material has been used to form a weakened plane in the transverse joint, it shall be completely sawed out and the saw cut pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures. Where a parallel crack goes part way across paving lane and then intersects and follows the original joint which is cracked only for the remained of the width, it shall be treated as specified above for a parallel crack, and the cracked original joint shall be prepared and sealed as originally designed.

**(2) Full depth cracks present, original joint also cracked.** At a joint, if there is any place in the lane width where a parallel crack and a cracked portion of the original joint overlap, the entire slab containing the crack shall be removed and replaced for the full lane width and length.

**e. Removal and replacement of full slabs.** Where it is necessary to remove full slabs, unless there are dowels present, all edges of the slab shall be cut full depth with a concrete saw. All saw cuts shall be perpendicular to the slab surface. If dowels, or tie bars are present along any edges, these edges shall be sawed full depth just beyond the end of the dowels or tie bars. These joints shall then be carefully sawed on the joint line to within one inch (25 mm) of the depth of the dowel or tie bar.

The main slab shall be further divided by sawing full depth, at appropriate locations, and each piece lifted out and removed. Suitable equipment shall be used to provide a truly vertical lift, and approved safe lifting devices used for attachment to the slabs. The narrow strips along doweled edges shall be carefully broken up and removed using light, hand-held jackhammers, 30 lb (14 kg) or less, or other approved similar equipment.

Care shall be taken to prevent damage to the dowels, tie bars, or to concrete to remain in place. The joint face below dowels shall be suitably trimmed so that there is not abrupt offset in any direction greater than 1/2 inch (12 mm) and no gradual offset greater than one inch (25 mm) when tested in a horizontal direction with a 12-foot (3.7-m) straightedge.

No mechanical impact breakers, other than the above hand-held equipment shall be used for any removal of slabs. If underbreak between 1-1/2 and 4 inches (38 and 100 mm) deep occurs at any point along any edge, the area shall be repaired as directed before replacing the removed slab. Procedures directed will be similar to those specified for surface spalls, modified as necessary.

If underbreak over 4 inches (100 mm) deep occurs, the entire slab containing the underbreak shall be removed and replaced. Where there are no dowels or tie bars, or where they have been damaged, dowels or tie bars of the size and spacing as specified for other joints in similar pavement shall be installed by epoxy grouting them into holes drilled into the existing concrete using procedures as specified. Original damaged dowels or tie bars shall be cut off flush with the joint face. Protruding portions of dowels shall be painted and lightly oiled. All four (4) edges of the new slab shall contain dowels or original tie bars.

Placement of concrete shall be as specified for original construction. Prior to placement of new concrete, the underlying material (unless it is stabilized) shall be re-compacted and shaped as specified in the appropriate section of these specifications. The surfaces of all four joint faces shall be cleaned of all loose material and contaminants and coated with a double application of membrane forming curing compound as bond breaker. Care shall be taken to prevent any curing compound from contacting dowels or tie bars. The resulting joints around the new slab shall be prepared and sealed as specified for original construction.

**f. Repairing spalls along joints.** Where directed, spalls along joints of new slabs, and along parallel cracks used as replacement joints, shall be repaired by first making a vertical saw cut at least one inch (25 mm) outside the spalled area and to a depth of at least 2 inch (50 mm). Saw cuts shall be straight lines forming rectangular areas. The concrete between the saw cut and the joint, or crack, shall be chipped out to remove all unsound concrete and at least 1/2 inch (12 mm) of visually sound concrete. The cavity thus formed shall be thoroughly cleaned with high-pressure water jets supplemented with compressed air to remove all loose material. Immediately before filling the cavity, a prime coat of epoxy resin, Type III, Grade I, shall be applied to the dry cleaned surface of all sides and bottom of the cavity, except any joint face. The prime coat shall be applied in a thin coating and scrubbed into the surface with a stiff-bristle brush. Pooling of epoxy resin shall be avoided. The cavity shall be filled with low slump Portland cement concrete or mortar or with epoxy resin concrete or mortar. Concrete shall be used for larger spalls, generally those more than 1/2 cu. ft. (0.014 m<sup>3</sup>) in size, and mortar shall be used for the smaller ones. Any spall less than 0.1 cu. ft. (0.003 m<sup>3</sup>) shall be repaired only with epoxy resin mortar or a Grade III epoxy resin. Portland cement concrete and mortar mixtures shall be proportioned as directed and shall be mixed, placed, consolidated, and cured as directed. Epoxy resin mortars shall be made with Type III, Grade 1, epoxy resin, using proportions and mixing and placing procedures as recommended by the manufacturer and approved

by the Engineer. The epoxy resin materials shall be placed in the cavity in layers not over 2 inches (50 mm) thick. The time interval between placement of additional layers shall be such that the temperature of the epoxy resin material does not exceed 140°F (60°C) at any time during hardening. Mechanical vibrators and hand tampers shall be used to consolidate the concrete or mortar. Any repair material on the surrounding surfaces of the existing concrete shall be removed before it hardens. Where the spalled area abuts a joint, an insert or other bond-breaking medium shall be used to prevent bond at the joint face. A reservoir for the joint sealant shall be sawed to the dimensions required for other joints, or as required to be routed for cracks. The reservoir shall be thoroughly cleaned and sealed with the sealer specified for the joints. If any spall penetrates half the depth of the slab or more, the entire slab shall be removed and replaced as previously specified. If any spall would require over 25% of the length of any single joint to be repaired, the entire slab shall be removed and replaced. Repair of spalls as described in this section shall not be allowed if in the opinion of the Engineer the overall condition of the pavement indicates that such repair is unlikely to achieve an acceptable and durable finished pavement. No repair of spalls shall be allowed in any panel that demonstrates segregated aggregate with a significant absence of coarse aggregate in the upper one-eighth (1/8th) inch of the pavement surface.

**g. Diamond grinding of PCC surfaces.** Diamond grinding of the hardened concrete with an approved diamond grinding machine should not be performed until the concrete is 14 days or more old and concrete has reached full minimum strength. When required, diamond grinding shall be accomplished by sawing with saw blades impregnated with industrial diamond abrasive. The saw blades shall be assembled in a cutting head mounted on a machine designed specifically for diamond grinding that will produce the required texture and smoothness level without damage to the pavement. The saw blades shall be 1/8-inch (3-mm) wide and there shall be a minimum of 55 to 60 blades per 12 inches (300 mm) of cutting head width; the actual number of blades will be determined by the Contractor and depend on the hardness of the aggregate. Each machine shall be capable of cutting a path at least 3 feet (0.9 m) wide. Equipment that causes ravels, aggregate fractures, spalls or disturbance to the joints will not be permitted. The area corrected by diamond grinding the surface of the hardened concrete should not exceed 10% of the total area of any subplot. The depth of diamond grinding shall not exceed 1/2 inch (13 mm) and all areas in which diamond grinding has been performed will be subject to the final pavement thickness tolerances specified. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. All pavement areas requiring plan grade or surface smoothness corrections in excess of the limits specified above, may require removing and replacing in conformance with paragraph 501-4.19.

#### **501-4.20 Existing concrete pavement removal and repair.**

All operations shall be carefully controlled to prevent damage to the concrete pavement and to the underlying material to remain in place. All saw cuts shall be made perpendicular to the slab surface.

##### **a. Removal of existing pavement slab.**

When it is necessary to remove existing concrete pavement and leave adjacent concrete in place, unless there are dowels present, the joint between the removal area and adjoining pavement to stay in place, shall first be cut full depth with a standard diamond-type concrete saw. If dowels are present at this joint, the saw cut shall be made full depth just beyond the end of dowels. The edge shall then be carefully sawed on the joint line to within one inch (25 mm) of the top of the dowel. Next, a full depth saw cut shall be made parallel to the joint at least 24 inches (600 mm) from the joint and at least 12 inches (300 mm) from the end of any dowels. All pavement between this last saw cut and the joint line shall be carefully broken up and removed using hand-held jackhammers, 30 lb (14 kg) or less, or the approved light-duty equipment which will not cause stress to propagate across the joint saw cut and cause distress in the pavement which is to remain in place. Where dowels are present, care shall be taken to produce an even, vertical joint face below the dowels. If the Contractor is unable to produce such a joint face, or if underbreak or other distress occurs,

the Contractor shall saw the dowels flush with the joint. The Contractor shall then install new dowels, of the size and spacing used for other similar joints, by epoxy resin bonding them in holes drilled in the joint face as specified in paragraph 501-4.10g. All this shall be at no additional cost to the Owner. Dowels of the size and spacing indicated shall be installed as shown on the drawings by epoxy resin bonding them in holes drilled in the joint face as specified in paragraph 501-4.10g. The joint face shall be sawed or otherwise trimmed so that there is no abrupt offset in any direction greater than 1/2 inches (12 mm) and no gradual offset greater than one-inch (25 mm) when tested in a horizontal direction with a 12-foot (3.7-m) straightedge.

**b. Edge repair.**

The edge of existing concrete pavement against which new pavement abuts shall be protected from damage at all times. Areas that are damaged during construction shall be repaired at no cost to the Owner.

**(1) Spall repair.** Spalls shall be repaired where indicated and where directed by the Engineer. Repair materials and procedures shall be as previously specified in subparagraph 501-4.19f.

**(2) Underbreak repair.** All underbreak shall be repaired. First, all delaminated and loose material shall be carefully removed. Next, the underlying material shall be recompacted, without addition of any new material. Finally, the void shall be completely filled with paving concrete, thoroughly consolidated. Care shall be taken to produce an even joint face from top to bottom. Prior to placing concrete, the underlying material shall be thoroughly moistened. After placement, the exposed surface shall be heavily coated with curing compound.

**(3) Underlying material.** The underlying material adjacent to the edge and under the existing pavement which is to remain in place shall be protected from damage or disturbance during removal operations and until placement of new concrete, and shall be shaped as shown on the drawings or as directed. Sufficient material shall be kept in place outside the joint line to prevent disturbance (or sloughing) of material under the pavement that is to remain in place. Any material under the portion of the concrete pavement to remain in place, which is disturbed or loses its compaction shall be carefully removed and replaced with concrete as specified in paragraph 501-4.20b(2). The underlying material outside the joint line shall be thoroughly compacted and moist when new concrete is placed.

## MATERIAL ACCEPTANCE

**501-5.1 Acceptance sampling and testing.** All acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the contractor and furnished to the Engineer. The Contractor shall bear the cost of providing curing facilities for the strength specimens, per paragraph 501-5.1a(3), and coring and filling operations, per paragraph 501-5.1b(1). Testing organizations performing these tests shall be accredited in accordance with ASTM C1077. The laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for acceptance sampling and testing must be listed on the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods shall be submitted to the Engineer prior to start of construction.

Concrete shall be accepted for strength and thickness on a lot basis.

A lot shall consist of a day's production not to exceed 2,000 square yards

**a. Flexural strength.**

**(1) Sampling.** Each lot shall be divided into four equal sublots. One sample shall be taken for each subplot from the plastic concrete delivered to the job site. Sampling locations shall be determined by the Engineer in accordance with random sampling procedures contained in ASTM D3665. The concrete shall be sampled in accordance with ASTM C172.

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**(2) Testing.** Two (2) specimens shall be made from each sample. Specimens shall be made in accordance with ASTM C31 and the flexural strength of each specimen shall be determined in accordance with ASTM C78. The flexural strength for each subplot shall be computed by averaging the results of the two test specimens representing that subplot.

Immediately prior to testing for flexural strength, the beam shall be weighed and measured for determination of a sample unit weight. Measurements shall be made for each dimension; height, depth, and length, at the mid-point of the specimen and reported to the nearest 1/10 inch (3 mm). The weight of the specimen shall be reported to the nearest 0.1 pound (45 gm). The sample unit weight shall be calculated by dividing the sample weight by the calculated volume of the sample. This information shall be reported as companion information to the measured flexural strength for each specimen.

The samples will be transported while in the molds. The curing, except for the initial cure period, will be accomplished using the immersion in saturated lime water method.

Slump, air content, and temperature tests will also be conducted by the quality assurance laboratory for each set of strength test samples, per ASTM C31.

**(3) Curing.** The Contractor shall provide adequate facilities for the initial curing of beams. During the 24 hours after molding, the temperature immediately adjacent to the specimens must be maintained in the range of 60° to 80°F (16° to 27°C), and loss of moisture from the specimens must be prevented. The specimens may be stored in tightly constructed wooden boxes, damp sand pits, temporary buildings at construction sites, under wet burlap in favorable weather, or in heavyweight closed plastic bags, or using other suitable methods, provided the temperature and moisture loss requirements are met.

**(4) Acceptance.** Acceptance of pavement for flexural strength will be determined by the Engineer in accordance with paragraph 501-5.2b.

**b. Pavement thickness.**

**(1) Testing.** The thickness will be determined by survey. No cores shall be taken on the pavement.

**(2) Acceptance.** Acceptance of pavement for thickness shall be determined by the Engineer in accordance with paragraph 501-5.2c.

**501-5.2 Acceptance criteria.**

**a. General.** Acceptance will be based on the following characteristics of the completed pavement discussed in paragraph 501-5.2e:

- (1) Flexural strength
- (2) Thickness
- (3) Smoothness
- (4) Grade
- (5) Edge slump

Flexural strength and thickness shall be evaluated for acceptance on a lot basis.

Acceptance for flexural strength will be based on the criteria contained in accordance with paragraph 501-5.2e(1). Acceptance for thickness will be based on the criteria contained in paragraph 501-5.2e(2). Acceptance for smoothness will be based on the criteria contained in paragraph 501-5.2e(3). Acceptance for grade will be based on the criteria contained in paragraph 501-5.2e(4).

The Engineer may at any time, notwithstanding previous plant acceptance, reject and require the Contractor to dispose of any batch of concrete mixture which is rendered unfit for use due to contamination, segregation, or improper slump. Such rejection may be based on only visual inspection. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the

Engineer, and if it can be demonstrated in the laboratory, in the presence of the Engineer, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

**b. Flexural strength.** Acceptance of each lot of in-place pavement for flexural strength shall be based on the average flexural strength. Any lot in which the average flexural strength does not meet the specified strength shall be removed and replaced at the contractor's expense.

**c. Pavement thickness.** Acceptance of each lot for pavement thickness shall be based on the average pavement of thickness of the lot. Any lot in which the average pavement thickness does not meet the specified thickness shall be removed and replaced at the contractor's expense.

**d. Smoothness.** As soon as the concrete has hardened sufficiently, but not later than 48 hours after placement, the surface of each lot shall be tested in both longitudinal and transverse directions for smoothness to reveal all surface irregularities exceeding the tolerances specified. The Contractor shall furnish paving equipment and employ methods that produce a finished surface of the pavement that shall not vary more than 1/4 inch (6mm) when evaluated with a 12-foot (3.7m) straightedge. When the surface smoothness exceeds specification tolerances which cannot be corrected by diamond grinding of the pavement, full depth removal and replacement of pavement shall be to the limit of the longitudinal placement. Corrections involving diamond grinding will be subject to the final pavement thickness tolerances specified.

(a) Transverse measurements. Transverse measurements will be taken for each lot placed. Transverse measurements will be taken perpendicular to the pavement centerline each 50 feet (15m) or more often as determined by the Engineer.

(i) Testing shall be continuous across all joints, starting with one-half the length of the straight edge at the edge of pavement section being tested and then moved ahead one-half the length of the straight edge for each successive measurement. Smoothness readings will not be made across grade changes or cross slope transitions; at these transition areas, the straightedge position shall be adjusted to measure surface smoothness and not design grade or cross slope transitions. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points. Deviations on final pavement > 1/4 inch (6mm) in transverse direction shall be corrected with diamond grinding per paragraph 501-4.19g or by removing and replacing full depth of pavement. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding should not exceed 10% of the total area and these areas shall be retested after grinding.

(ii) The joint between lots shall be tested separately to facilitate smoothness between lots. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface, with half the straightedge on one side of the joint and the other half of the straightedge on the other side of the joint. Measure the maximum gap between the straightedge and the pavement surface in the area between these two high points. One measurement shall be taken at the joint every 50 feet (15m) or more often if directed by the Engineer. Maximum gap on final pavement surface > 1/4 inch (6mm) in transverse direction shall be corrected with diamond grinding per paragraph 501-4.19g or by removing and replacing full depth of surface. Each measurement shall be recorded and a copy of the data shall be furnished to the Engineer at the end of each days testing.

(b) Longitudinal measurements. Longitudinal measurements will be taken for each lot placed. Longitudinal tests will be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6m); and at the one third points of paving lanes when widths of paving lanes are 20 ft (6m) or greater.

(i) **Longitudinal Short Sections.** Longitudinal Short Sections are when the longitudinal lot length is less than 200 feet (60m) and areas not requiring a profilograph. When approved by the Engineer, the first and last 15 feet (4.5m) of the lot can also be considered as short sections for smoothness. The finished surface shall not vary more than 1/4 inch (6mm) when evaluated with a 12-foot (3.7m) straightedge. Smoothness readings will not be made across grade changes or cross slope transitions, at these transition areas, the straightedge position shall be adjusted to measure surface smoothness and not design grade or cross slope transitions. Testing shall be continuous across all joints, starting with one-half the length of the straight edge at the edge of pavement section being tested and then moved ahead one-half the length of the straight edge for each successive measurement. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points. Deviations on final pavement surface > 1/4 inch (6mm) in longitudinal direction will be corrected with diamond grinding per paragraph 501-4.19g or by removing and replacing full depth of surface. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding should not exceed 10% of the total area and these areas shall be retested after grinding.

**e. Grade.** An evaluation of the surface grade shall be made by the Engineer for compliance to the tolerances contained below. The finish grade will be determined by running levels at intervals of 50 feet (15 m) or less longitudinally and all breaks in grade transversely (not to exceed 50 feet (15 m)) to determine the elevation of the completed pavement. The Contractor shall pay the costs of surveying the level runs, and this work shall be performed by a licensed surveyor. The documentation, stamped and signed by a licensed surveyor, shall be provided by the Contractor to the Engineer.

**(a) Lateral deviation.** Lateral deviation from established alignment of the pavement edge shall not exceed ±0.10 feet (3 mm) in any lane.

**(b) Vertical deviation.** Vertical deviation from established grade shall not exceed ±0.04 feet (12 mm) at any point.

All slabs that do not meet the grade requirements shall be removed and replaced at the Contractor's expense.

**f. Edge slump.** When excessive edge slump cannot be corrected before the concrete has hardened, the area with excessive edge slump shall be removed and replaced at the expense of the Contractor as directed by the Engineer in accordance with paragraph 501-4.8a.

**f. Removal and replacement of concrete.** Any area or section of concrete that is removed and replaced shall be removed and replaced back to planned joints. The Contractor shall replace damaged dowels and the requirements for doweled longitudinal construction joints in paragraph 501-4.10 shall apply to all contraction joints exposed by concrete removal. Removal and replacement shall be in accordance with paragraph 501-4.20.

## CONTRACTOR QUALITY CONTROL

**501-6.1 Quality control program.** The Contractor shall develop a Quality Control Program in accordance with Section 100 of the General Provisions. The program shall address all elements that affect the quality of the pavement including but not limited to:

- a. Mix Design
- b. Aggregate Gradation
- c. Quality of Materials
- d. Stockpile Management
- e. Proportioning

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- f. Mixing and Transportation
- g. Placing and Consolidation
- h. Joints
- i. Dowel Placement and Alignment
- j. Flexural or Compressive Strength
- k. Finishing and Curing
- l. Surface Smoothness

**501-6.2 Quality control testing.** The Contractor shall perform all quality control tests necessary to control the production and construction processes applicable to this specification and as set forth in the Quality Control Program. The testing program shall include, but not necessarily be limited to, tests for aggregate gradation, aggregate moisture content, slump, and air content.

A Quality Control Testing Plan shall be developed as part of the Quality Control Program.

**a. Fine aggregate.**

(1) **Gradation.** A sieve analysis shall be made at least twice daily in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

(2) **Moisture content.** If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C70 or ASTM C566.

**b. Coarse Aggregate.**

(1) **Gradation.** A sieve analysis shall be made at least twice daily for each size of aggregate. Tests shall be made in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

(2) **Moisture content.** If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C566.

**c. Slump.** Four slump tests shall be performed for each lot of material produced in accordance with the lot size defined in paragraph 501-5.1. One test shall be made for each subplot. Slump tests shall be performed in accordance with ASTM C143 from material randomly sampled from material discharged from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

**d. Air content.** Four air content tests, shall be performed for each lot of material produced in accordance with the lot size defined in paragraph 501-5.1. One test shall be made for each subplot. Air content tests shall be performed in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag or other porous coarse aggregate, from material randomly sampled from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

**e.** Four unit weight and yield tests shall be made in accordance with ASTM C138. The samples shall be taken in accordance with ASTM C172 and at the same time as the air content tests.

**501-6.3 Control charts.** The Contractor shall maintain linear control charts for fine and coarse aggregate gradation, slump, moisture content and air content.

Control charts shall be posted in a location satisfactory to the Engineer and shall be kept up to date at all times. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and suspension Limits, or Specification limits, applicable to each test parameter, and the Contractor’s test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the Contractor’s projected data during production indicates a potential problem and the Contractor is not taking satisfactory corrective action, the Engineer may halt production or acceptance of the material.

**a. Fine and coarse aggregate gradation.** The Contractor shall record the running average of the last five gradation tests for each control sieve on linear control charts. Specification limits contained in the Lower Specification Tolerance Limit (L) table above and the Control Chart Limits table below shall be superimposed on the Control Chart for job control.

**b. Slump and air content.** The Contractor shall maintain linear control charts both for individual measurements and range (that is, difference between highest and lowest measurements) for slump and air content in accordance with the following Action and Suspension Limits.

**Control Chart Limits**

Control Parameter	Individual Measurements		Range Suspension Limit
	Action Limit	Suspension Limit	
<b>Slip Form:</b>			
Slump	+0 to -1 inch (0-25 mm)	+0.5 to -1.5 inch (13-38 mm)	±1.5 inch (38 mm)
Air Content	±1.2%	±1.8%	±2.5%
<b>Side Form:</b>			
Slump	+0.5 to -1 inch (13-25 mm)	+1 to -1.5 inch (25-38 mm)	±1.5 inch (38 mm)
Air Content	±1.2%	±1.8%	±2.5%

The individual measurement control charts shall use the mix design target values as indicators of central tendency.

**501-6.4 Corrective action.** The Contractor Quality Control Program shall indicate that appropriate action shall be taken when the process is believed to be out of control. The Contractor Quality Control Program shall detail what action will be taken to bring the process into control and shall contain sets of rules to gauge when a process is out of control. As a minimum, a process shall be deemed out of control and corrective action taken if any one of the following conditions exists.

**a. Fine and coarse aggregate gradation.** When two consecutive averages of five tests are outside of the specification limits in paragraph 501-2.1, immediate steps, including a halt to production, shall be taken to correct the grading.

**b. Fine and coarse aggregate moisture content.** Whenever the moisture content of the fine or coarse aggregate changes by more than 0.5%, the scale settings for the aggregate batcher and water batcher shall be adjusted.

**c. Slump.** The Contractor shall halt production and make appropriate adjustments whenever:

(1) one point falls outside the Suspension Limit line for individual measurements or range

OR

(2) two points in a row fall outside the Action Limit line for individual measurements.

**d. Air content.** The Contractor shall halt production and adjust the amount of air-entraining admixture whenever:

(1) one point falls outside the Suspension Limit line for individual measurements or range

OR

(2) two points in a row fall outside the Action Limit line for individual measurements.

Whenever a point falls outside the Action Limits line, the air-entraining admixture dispenser shall be calibrated to ensure that it is operating correctly and with good reproducibility.

### TESTING REQUIREMENTS

ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C70	Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C117	Standard Test Method for Materials Finer Than 75- $\mu$ m (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C174	Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C227	Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C289	Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)
ASTM C295	Standard Guide for Petrographic Examination of Aggregates for Concrete

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ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C311	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland Cement Concrete
ASTM C566	Standard Test Method for Total Evaporable Moisture Content of Aggregates by Drying
ASTM C642	Standard Test Method for Density, Absorption, and Voids in Hardened Concrete
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1567	Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM E178	Standard Practice for Dealing With Outlying Observations
ASTM E1274	Standard Test Method for Measuring Pavement Roughness Using a Profilograph
U.S. Army Corps of Engineers (USACE) Concrete Research Division (CRD) C662	Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials, Lithium Nitrate Admixture and Aggregate (Accelerated Mortar-Bar Method)

### **MATERIAL REQUIREMENTS**

ASTM A184	Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A704	Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
ASTM A706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A714	Standard Specification for High-Strength Low-Alloy Welded and Seamless Steel Pipe
ASTM A775	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A934	Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars

ASTM A996	Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1078	Standard Specification for Epoxy-Coated Steel Dowels for Concrete Pavement
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving And Structural Construction
ACI 211.1	Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete
ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting
ACI 309R	Guide for Consolidation of Concrete
AC 150/5320-6	Airport Pavement Design and Evaluation
PCA	Design and Control of Concrete Mixtures

**END ITEM P-501**



## ITEM P-603 BITUMINOUS TACK COAT

### DESCRIPTION

**603-1.1** This item shall consist of preparing and treating a bituminous or concrete surface with bituminous material in accordance with these specifications and in reasonably close conformity to the lines shown on the plans.

### MATERIALS

**603-2.1 Bituminous materials.** The bituminous material shall be an emulsified asphalt indicated in ASTM D3628 as a bituminous application for tack coat appropriate to local conditions or as designated by the Engineer.

### CONSTRUCTION METHODS

**603-3.1 Weather limitations.** The tack coat shall be applied only when the existing surface is dry and the atmospheric temperature is 50°F (10°C) or above; the temperature has not been below 35°F (2°C) for the 12 hours prior to application; and when the weather is not foggy or rainy. The temperature requirements may be waived when directed by the Engineer.

**603-3.2 Equipment.** The Contractor shall provide equipment for heating and applying the bituminous material.

Provide a distributor with pneumatic tires of such size and number that the load produced on the base surface does not exceed 65.0 psi (4.5 kg/sq cm) of tire width to prevent rutting, shoving or otherwise damaging the base, surface or other layers in the pavement structure. Design and equip the distributor to spray the bituminous material in a uniform coverage at the specified temperature, at readily determined and controlled rates from 0.05 to 2.0 gallons per square yard (0.23 to 9.05 L/square meter), with a pressure range of 25 to 75 psi (172.4 to 517.1 kPa) and with an allowable variation from the specified rate of not more than ±5%, and at variable widths. Include with the distributor equipment a separate power unit for the bitumen pump, full-circulation spray bars, tachometer, pressure gauges, volume-measuring devices, adequate heaters for heating of materials to the proper application temperature, a thermometer for reading the temperature of tank contents, and a hand hose attachment suitable for applying bituminous material manually to areas inaccessible to the distributor. Equip the distributor to circulate and agitate the bituminous material during the heating process. If the distributor is not equipped with an operable quick shutoff valve, the tack operations shall be started and stopped on building paper. The Contractor shall remove blotting sand prior to asphalt concrete lay down operations at no additional expense to the Owner.

A power broom and/or power blower suitable for cleaning the surfaces to which the bituminous tack coat is to be applied shall be provided.

**603-3.3 Application of bituminous material.** Immediately before applying the tack coat, the full width of surface to be treated shall be swept with a power broom and/or power blower to remove all loose dirt and other objectionable material.

Emulsified asphalt shall be diluted by the addition of water when directed by the Engineer and shall be applied a sufficient time in advance of the paver to ensure that all water has evaporated before the overlying mixture is placed on the tacked surface.

The bituminous material including vehicle shall be uniformly applied with a bituminous distributor at the rate of 0.05 to 0.10 gallons per square yard (0.20 to 0.50 liters per square meter) depending on the condition

of the existing surface. The type of bituminous material and application rate shall be approved by the Engineer prior to application.

After application of the tack coat, the surface shall be allowed to cure without being disturbed for the period of time necessary to permit drying and setting of the tack coat. This period shall be determined by the Engineer. The Contractor shall protect the tack coat and maintain the surface until the next course has been placed.

**603-3.4 Bituminous material Contractor’s responsibility.** The Contractor shall provide a statement of source and character of the proposed bituminous material which must be submitted and approved by the Engineer before any shipment of bituminous materials to the project.

The Contractor shall furnish the vendor’s certified test reports for each carload, or equivalent, of bituminous material shipped to the project. The tests reports shall be provided to and approved by the Engineer before the bituminous material is applied. If the bituminous material does not meet the specifications, it shall be replaced at the Contractor’s expense. Furnishing the vendor’s certified test report for the bituminous material shall not be interpreted as a basis for final acceptance.

**603-3.5 Freight and weigh bills** The Contractor shall submit waybills and delivery tickets, during progress of the work. Before the final statement is allowed, file with the Engineer certified waybills and certified delivery tickets for all bituminous materials used in the construction of the pavement covered by the contract. Do not remove bituminous material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken.

**MATERIAL REQUIREMENTS**

ASTM D633	Standard Volume Correction Table for Road Tar
ASTM D977	Standard Specification for Emulsified Asphalt
ASTM D1250	Standard Guide for Use of the Petroleum Measurement Tables
ASTM D2028	Standard Specification for Cutback Asphalt (Rapid-Curing Type)
ASTM D2397	Standard Specification for Cationic Emulsified Asphalt
ASTM D3628	Standard Practice for Selection and Use of Emulsified Asphalts

**END ITEM P-603**

## ITEM P-605 JOINT SEALANTS FOR CONCRETE PAVEMENTS

### DESCRIPTION

**605-1.1** This item shall consist of providing and installing a resilient and adhesive joint sealing material capable of effectively sealing joints and cracks in rigid pavements.

### MATERIALS

**605-2.1 Joint sealants.** Joint sealant materials shall meet the requirements of ASTM D5893 Standard Specifications for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.

Each lot or batch of sealant shall be delivered to the jobsite in the manufacturer's original sealed container. Each container shall be marked with the manufacturer's name, batch or lot number, the safe heating temperature, and shall be accompanied by the manufacturer's certification stating that the sealant meets the requirements of this specification.

**605-2.2 Backer rod.** The material furnished shall be a compressible, non-shrinking, non-staining, non-absorbing material that is non-reactive with the joint sealant. The material shall have a water absorption of not more than 5% when tested in accordance with ASTM C509. The backer-rod material shall be  $25\% \pm 5\%$  larger in diameter than the nominal width of the crack.

**605-2.3 Backup materials.** Provide backup material that is a compressible, nonshrinking, nonstaining, nonabsorbing material, nonreactive with the joint sealant. The material shall have a melting point at least  $5^{\circ}\text{F}$  ( $3^{\circ}\text{C}$ ) greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. The material shall have a water absorption of not more than 5% of the sample weight when tested in accordance with ASTM C509. The backup material shall be  $25 \pm 5\%$  larger in diameter than the nominal width of the crack.

**605-2.4 Bond breaking tapes.** Provide a bond breaking tape or separating material that is a flexible, nonshrinkable, nonabsorbing, nonstaining, and nonreacting adhesive-backed tape. The material shall have a melting point at least  $5^{\circ}\text{F}$  ( $3^{\circ}\text{C}$ ) greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. The bond breaker tape shall be approximately 1/8 inch (3 mm) wider than the nominal width of the joint and shall not bond to the joint sealant.

### CONSTRUCTION METHODS

**605-3.1 Time of application.** Joints shall be sealed as soon after completion of the curing period as feasible and before the pavement is opened to traffic, including construction equipment. The pavement temperature shall be  $50^{\circ}\text{F}$  ( $10^{\circ}\text{C}$ ) and rising at the time of application of the poured joint sealing material. Do not apply sealant if moisture is observed in the joint.

**605-3.2 Equipment.** Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and maintained in satisfactory condition at all times. Submit a list of proposed equipment to be used in performance of construction work including descriptive data, 14 days prior to use on the project.

**a. Tractor-mounted routing tool.** *Not required for this project.*

**b. Concrete saw.** Provide a self-propelled power saw, with water-cooled diamond or abrasive saw blades, for cutting joints to the depths and widths specified or for refacing joints or cleaning sawed joints where sandblasting does not provide a clean joint.

**c. Sandblasting equipment.** Include with the sandblasting equipment an air compressor, hose, and long-wearing venturi-type nozzle of proper size, shape and opening. The maximum nozzle opening should not exceed 1/4 inch (6 mm). The air compressor shall be portable and capable of furnishing not less than 150 cfm (71 L/s) and maintaining a line pressure of not less than 90 psi (621 kPa) at the nozzle while in use. Demonstrate compressor capability, under job conditions, before approval. The compressor shall be equipped with traps that will maintain the compressed air free of oil and water. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the joint approximately one inch (25 mm) above the pavement surface. Adjust the height, angle of inclination and the size of the nozzle as necessary to secure satisfactory results.

**. Waterblasting equipment.** Include with the waterblasting equipment a trailer-mounted water tank, pumps, high-pressure hose, wand with safety release cutoff control, nozzle, and auxiliary water resupply equipment. Provide water tank and auxiliary resupply equipment of sufficient capacity to permit continuous operations. The nozzle shall have an adjustable guide that will hold the nozzle aligned with the joint approximately one inch (25 mm) above the pavement surface. Adjust the height, angle of inclination and the size of the nozzle as necessary to obtain satisfactory results. A pressure gauge mounted at the pump shall show at all times the pressure in psi (kPa) at which the equipment is operating.

**e. Hand tools.** Hand tools may be used, when approved, for removing defective sealant from a crack and repairing or cleaning the crack faces.

**f. Hot-poured sealing equipment.** The unit applicators used for heating and installing ASTM D6690 joint sealant materials shall be mobile and shall be equipped with a double-boiler, agitator-type kettle with an oil medium in the outer space for heat transfer; a direct-connected pressure-type extruding device with a nozzle shaped for inserting in the joint to be filled; positive temperature devices for controlling the temperature of the transfer oil and sealant; and a recording type thermometer for indicating the temperature of the sealant. The applicator unit shall be designed so that the sealant will circulate through the delivery hose and return to the inner kettle when not in use.

**g. Two-component, cold-applied, machine mix sealing equipment.** *Not required for this project.*

**h. Two-component, cold-applied, hand-mix sealing equipment.** *Not required for this project.*

**i. Cold-applied, single-component sealing equipment.** The equipment for installing ASTM D5893 single component joint sealants shall consist of an extrusion pump, air compressor, following plate, hoses, and nozzle for transferring the sealant from the storage container into the joint opening. The dimension of the nozzle shall be such that the tip of the nozzle will extend into the joint to allow sealing from the bottom of the joint to the top. Maintain the initially approved equipment in good working condition, serviced in accordance with the supplier's instructions, and unaltered in any way without obtaining prior approval. Small hand-held air-powered equipment (i.e., caulking guns) may be used for small applications.

### 605-3.3 Preparation of joints.

**a. Sawing.** All joints shall be sawed in accordance with specifications and plan details. Immediately after sawing the joint, the resulting slurry shall be completely removed from joint and adjacent area by flushing with a jet of water, and by use of other tools as necessary.

**b. Sealing.** Immediately before sealing, the joints shall be thoroughly cleaned of all remaining laitance, curing compound, filler, protrusions of hardened concrete, old sealant and other foreign material from the sides and upper edges of the joint space to be sealed. Cleaning shall be accomplished by sandblasting, concrete saw or waterblaster as specified in paragraph 605-3.2. The newly exposed concrete joint faces and the pavement surface extending a minimum of 1/2 inch (12 mm) from the joint edge shall be sandblasted clean. Sandblasting shall be accomplished in a minimum of two passes. One pass per joint face with the nozzle held at an angle directly toward the joint face and not more than 3 inches (75 mm)

from it. After final cleaning and immediately prior to sealing, blow out the joints with compressed air and leave them completely free of debris and water. The joint faces shall be surface dry when the seal is applied.

**c. Back-up material.** When the joint opening is of a greater depth than indicated for the sealant depth, plug or seal off the lower portion of the joint opening using a back-up material to prevent the entrance of the sealant below the specified depth. Take care to ensure that the backup material is placed at the specified depth and is not stretched or twisted during installation.

**d. Bond-breaking tape.** Where inserts or filler materials contain bitumen, or the depth of the joint opening does not allow for the use of a backup material, insert a bond-breaker separating tape to prevent incompatibility with the filler materials and three-sided adhesion of the sealant. Securely bond the tape to the bottom of the joint opening so it will not float up into the new sealant.

**605-3.4 Installation of sealants.** Joints shall be inspected for proper width, depth, alignment, and preparation, and shall be approved by the Engineer before sealing is allowed. Sealants shall be installed in accordance with the following requirements:

Immediately preceding, but not more than 50 feet (15 m) ahead of the joint sealing operations, perform a final cleaning with compressed air. Fill the joints from the bottom up to 1/4 inch ±1/16 inch (2 mm) below the pavement surface. Remove and discard excess or spilled sealant from the pavement by approved methods. Install the sealant in such a manner as to prevent the formation of voids and entrapped air. In no case shall gravity methods or pouring pots be used to install the sealant material. Traffic shall not be permitted over newly sealed pavement until authorized by the Contracting Officer. When a primer is recommended by the manufacturer, apply it evenly to the joint faces in accordance with the manufacturer's instructions. Check the joints frequently to ensure that the newly installed sealant is cured to a tack-free condition within the time specified.

**605-3.5 Inspection.** The Contractor shall inspect the joint sealant for proper rate of cure and set, bonding to the joint walls, cohesive separation within the sealant, reversion to liquid, entrapped air and voids. Sealants exhibiting any of these deficiencies at any time prior to the final acceptance of the project shall be removed from the joint, wasted, and replaced as specified at no additional cost to the airport.

**605-3.6 Clean-up.** Upon completion of the project, remove all unused materials from the site and leave the pavement in a clean condition.

### TESTING REQUIREMENTS

ASTM D412	Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension
ASTM D5893	Standard Specifications for Cold Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.
ASTM C509	Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material
ASTM D1644	Standard Test Methods for Nonvolatile Content of Varnishes

### MATERIAL REQUIREMENTS

AC 150/5340-30	Design and Installation Details for Airport Visual Aids
ASTM D789	Standard Test Method for Determination of Relative Viscosity of Polyamide (PA)

ASTM D5893 Standard Specification for Cold Applied, Single Component, Chemically Curing  
Silicone Joint Sealant for Portland Cement Concrete Pavements

ASTM D6690 Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and  
Asphalt Pavements

**END ITEM P-605**

**Item T-901 Seeding**

**DESCRIPTION**

**901-1.1** This item shall consist of soil preparation, seeding and fertilizing the areas shown on the plans or as directed by the Engineer in accordance with these specifications.

**MATERIALS**

**901-2.1 Seed.** The species and application rates of grass, legume, and cover-crop seed furnished shall be those stipulated herein. Seed shall conform to the requirements of Federal Specification JJJ-S-181, Federal Specification, Seeds, Agricultural.

Seed shall be furnished separately or in mixtures in standard containers labeled in conformance with the Agricultural Marketing Service (AMS) Seed Act and applicable state seed laws with the seed name, lot number, net weight, percentages of purity and of germination and hard seed, and percentage of maximum weed seed content clearly marked for each kind of seed. The Contractor shall furnish the Engineer duplicate signed copies of a statement by the vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing within six (6) months of date of delivery. This statement shall include: name and address of laboratory, date of test, lot number for each kind of seed, and the results of tests as to name, percentages of purity and of germination, and percentage of weed content for each kind of seed furnished, and, in case of a mixture, the proportions of each kind of seed. Wet, moldy, or otherwise damaged seed will be rejected.

Seeds shall be MDOT TDS applied as follows:

<b>Seed</b>	<b>Minimum Seed Purity (Percent)</b>	<b>Minimum Germination (Percent)</b>	<b>Rate of Application lb/acre (or lb/1,000 S.F.)</b>
Kentucky Bluegrass	98	85	11
Perennial Ryegrass	96	85	55
Hard Fescue	97	85	55
Creeping Red Fescue	97	85	99

Seeding shall be performed during the period between April 15 to June 5 and September 1 to October 5 inclusive, unless otherwise approved by the Engineer.

**901-2.2 Lime.** *Not Required for this project*

**901-2.3 Fertilizer.** Fertilizer shall be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. They shall be applied at the rate and to the depth specified, and shall meet the requirements of applicable state laws. They shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.

The fertilizers may be supplied in one of the following forms:

- a. A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;
- b. A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or
- c. A granular or pellet form suitable for application by blower equipment.

Fertilizers shall be 12-12-12 commercial fertilizer and shall be spread at the rate of 400 pounds per acre.

**901-2.4 Soil for repairs.** The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and shall be approved by the Engineer before being placed.

## CONSTRUCTION METHODS

**901-3.1 Advance preparation and cleanup.** After grading of areas has been completed and before applying fertilizer and ground limestone, areas to be seeded shall be raked or otherwise cleared of stones larger than 2 inches (50 mm) in any diameter, sticks, stumps, and other debris that might interfere with sowing of seed, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes has occurred after the completion of grading and before beginning the application of fertilizer and ground limestone, the Contractor shall repair such damage include filling gullies, smoothing irregularities, and repairing other incidental damage.

An area to be seeded shall be considered a satisfactory seedbed without additional treatment if it has recently been thoroughly loosened and worked to a depth of not less than 5 inches (125 mm) as a result of grading operations and, if immediately prior to seeding, the top 3 inches (75 mm) of soil is loose, friable, reasonably free from large clods, rocks, large roots, or other undesirable matter, and if shaped to the required grade.

When the area to be seeded is sparsely sodded, weedy, barren and unworked, or packed and hard, any grass and weeds shall first be cut or otherwise satisfactorily disposed of, and the soil then scarified or otherwise loosened to a depth not less than 5 inches (125 mm). Clods shall be broken and the top 3 inches (75 mm) of soil shall be worked into a satisfactory seedbed by discing, or by use of cultipackers, rollers, drags, harrows, or other appropriate means.

### **901-3.2 Dry application method.**

**a. Fertilizing.** Following advance preparations and cleanup fertilizer shall be uniformly spread at the rate that will provide not less than the minimum quantity stated in paragraph 901-2.3.

**b. Seeding.** Grass seed shall be sown at the rate specified in paragraph 901-2.1 immediately after fertilizing. The fertilizer and seed shall be raked within the depth range stated in the special provisions. Seeds of legumes, either alone or in mixtures, shall be inoculated before mixing or sowing, in accordance with the instructions of the manufacturer of the inoculant. When seeding is required at other than the seasons shown on the plans or in the special provisions, a cover crop shall be sown by the same methods required for grass and legume seeding.

**c. Rolling.** After the seed has been properly covered, the seedbed shall be immediately compacted by means of an approved lawn roller, weighing 40 to 65 pounds per foot (60 to 97 kg per meter) of width for clay soil (or any soil having a tendency to pack), and weighing 150 to 200 pounds per foot (223 to 298 kg per meter) of width for sandy or light soils.

### **901-3.3 Wet application method.**

**a. General.** The Contractor may elect to apply seed and fertilizer (and lime, if required) by spraying them on the previously prepared seedbed in the form of an aqueous mixture and by using the methods and equipment described herein. The rates of application shall be as specified in the special provisions.

**b. Spraying equipment.** The spraying equipment shall have a container or water tank equipped with a liquid level gauge calibrated to read in increments not larger than 50 gallons (190 liters) over the entire range of the tank capacity, mounted so as to be visible to the nozzle operator. The container or tank shall



also be equipped with a mechanical power-driven agitator capable of keeping all the solids in the mixture in complete suspension at all times until used.

The unit shall also be equipped with a pressure pump capable of delivering 100 gallons (380 liters) per minute at a pressure of 100 lb / sq inches (690 kPa). The pump shall be mounted in a line that will recirculate the mixture through the tank whenever it is not being sprayed from the nozzle. All pump passages and pipe lines shall be capable of providing clearance for 5/8 inch (16 mm) solids. The power unit for the pump and agitator shall have controls mounted so as to be accessible to the nozzle operator. There shall be an indicating pressure gauge connected and mounted immediately at the back of the nozzle.

The nozzle pipe shall be mounted on an elevated supporting stand in such a manner that it can be rotated through 360 degrees horizontally and inclined vertically from at least 20 degrees below to at least 60 degrees above the horizontal. There shall be a quick-acting, three-way control valve connecting the recirculating line to the nozzle pipe and mounted so that the nozzle operator can control and regulate the amount of flow of mixture delivered to the nozzle. At least three different types of nozzles shall be supplied so that mixtures may be properly sprayed over distance varying from 20 to 100 feet (6 to 30 m). One shall be a close-range ribbon nozzle, one a medium-range ribbon nozzle, and one a long-range jet nozzle. For case of removal and cleaning, all nozzles shall be connected to the nozzle pipe by means of quick-release couplings.

In order to reach areas inaccessible to the regular equipment, an extension hose at least 50 feet (15 m) in length shall be provided to which the nozzles may be connected.

**c. Mixtures.** Lime, if required, shall be applied separately, in the quantity specified, prior to the fertilizing and seeding operations. Not more than 220 pounds (100 kg) of lime shall be added to and mixed with each 100 gallons (380 liters) of water. Seed and fertilizer shall be mixed together in the relative proportions specified, but not more than a total of 220 pounds (100 kg) of these combined solids shall be added to and mixed with each 100 gallons (380 liters) of water.

All water used shall be obtained from fresh water sources and shall be free from injurious chemicals and other toxic substances harmful to plant life. Brackish water shall not be used at any time. The Contractor shall identify to the Engineer all sources of water at least two (2) weeks prior to use. The Engineer may take samples of the water at the source or from the tank at any time and have a laboratory test the samples for chemical and saline content. The Contractor shall not use any water from any source that is disapproved by the Engineer following such tests.

All mixtures shall be constantly agitated from the time they are mixed until they are finally applied to the seedbed. All such mixtures shall be used within two (2) hours from the time they were mixed or they shall be wasted and disposed of at approved locations.

**d. Spraying.** Lime, if required, shall be sprayed only upon previously prepared seedbeds. After the applied lime mixture has dried, the lime shall be worked into the top 3 inches (75 mm), after which the seedbed shall again be properly graded and dressed to a smooth finish.

Mixtures of seed and fertilizer shall only be sprayed upon previously prepared seedbeds on which the lime, if required, shall already have been worked in. The mixtures shall be applied by means of a high-pressure spray that shall always be directed upward into the air so that the mixtures will fall to the ground like rain in a uniform spray. Nozzles or sprays shall never be directed toward the ground in such a manner as might produce erosion or runoff.

Particular care shall be exercised to ensure that the application is made uniformly and at the prescribed rate and to guard against misses and overlapped areas. Proper predetermined quantities of the mixture in accordance with specifications shall be used to cover specified sections of known area.

Checks on the rate and uniformity of application may be made by observing the degree of wetting of the ground or by distributing test sheets of paper or pans over the area at intervals and observing the quantity of material deposited thereon.

On surfaces that are to be mulched as indicated by the plans or designated by the Engineer, seed and fertilizer applied by the spray method need not be raked into the soil or rolled. However, on surfaces on which mulch is not to be used, the raking and rolling operations will be required after the soil has dried.

**901-3.4 Maintenance of seeded areas.** The Contractor shall protect seeded areas against traffic or other use by warning signs or barricades, as approved by the Engineer. Surfaces gullied or otherwise damaged following seeding shall be repaired by regrading and reseeding as directed. The Contractor shall mow, water as directed, and otherwise maintain seeded areas in a satisfactory condition until final inspection and acceptance of the work.

When either the dry or wet application method outlined above is used for work done out of season, it will be required that the Contractor establish a good stand of grass of uniform color and density to the satisfaction of the Engineer. A grass stand shall be considered adequate when bare spots are one square foot (0.01 sq m) or less, randomly dispersed, and do not exceed 3% of the area seeded.

#### **MATERIAL REQUIREMENTS**

ASTM C602	Standard Specification for Agricultural Liming Materials
ASTM D977	Standard Specification for Emulsified Asphalt
FED SPEC	JJJ-S-181, Federal Specification, Seeds, Agricultural

**END OF ITEM T-901**

## ITEM T-905 TOPSOILING

### DESCRIPTION

**905-1.1** This item shall consist of preparing the ground surface for topsoil application, removing topsoil from designated stockpiles or areas to be stripped on the site or from approved sources off the site, and placing, spreading and amending the topsoil on prepared areas in accordance with this specification at the locations shown on the plans or as directed by the Engineer.

### MATERIALS

**905-2.1 Topsoil.** Topsoil shall be the surface layer of soil with no admixture of refuse or any material toxic to plant growth, and it shall be reasonably free from subsoil and stumps, roots, brush, stones (2 inches (50 mm) or more in diameter), and clay lumps or similar objects. Brush and other vegetation that will not be incorporated with the soil during handling operations shall be cut and removed. Ordinary sod and herbaceous growth such as grass and weeds are not to be removed, but shall be thoroughly broken up and intermixed with the soil during handling operations. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means, shall be removed. The topsoil or soil mixture, unless otherwise specified or approved, shall have a pH range of approximately 5.5 pH to 7.6 pH, when tested in accordance with the methods of testing of the Association of Official Agricultural Chemists in effect on the date of invitation of bids. The organic content shall be not less than 3% nor more than 20% as determined by the wet-combustion method (chromic acid reduction). There shall be not less than 20% nor more than 80% of the material passing the 200 mesh (0.075 mm) sieve as determined by the wash test in accordance with ASTM C117.

Natural topsoil may be amended by the Contractor with approved materials and methods to meet the above specifications.

**905-2.2 Inspection and tests.** Within 10 days following acceptance of the bid, the Engineer shall be notified of the source of topsoil to be furnished by the Contractor. The topsoil shall be inspected to determine if the selected soil meets the requirements specified and to determine the depth to which stripping will be permitted. At this time, the Contractor may be required to take representative soil samples from several locations within the area under consideration and to the proposed stripping depths, for testing purposes as specified in paragraph 905-2.1.

### CONSTRUCTION METHODS

**905-3.1 General.** Areas to be topsoiled shall be shown on the plans. If topsoil is available on the site, the location of the stockpiles or areas to be stripped of topsoil and the stripping depths shall be shown on the plans.

Suitable equipment necessary for proper preparation and treatment of the ground surface, stripping of topsoil, and for the handling and placing of all required materials shall be on hand, in good condition, and approved by the Engineer before the various operations are started.

**905-3.2 Preparing the ground surface.** Immediately prior to dumping and spreading the topsoil on any area, the surface shall be loosened by discs or spike-tooth harrows, or by other means approved by the Engineer, to a minimum depth of 2 inches (50 mm) to facilitate bonding of the topsoil to the covered subgrade soil. The surface of the area to be topsoiled shall be cleared of all stones larger than 2 inches (50 mm) in any diameter and all litter or other material which may be detrimental to proper bonding, the rise

of capillary moisture, or the proper growth of the desired planting. Limited areas, as shown on the plans, which are too compact to respond to these operations shall receive special scarification.

Grades on the area to be topsoiled, which have been established by others as shown on the plans, shall be maintained in a true and even condition. Where grades have not been established, the areas shall be smooth-graded and the surface left at the prescribed grades in an even and compacted condition to prevent the formation of low places or pockets where water will stand.

**905-3.3 Obtaining topsoil.** Prior to the stripping of topsoil from designated areas, any vegetation, briars, stumps and large roots, rubbish or stones found on such areas, which may interfere with subsequent operations, shall be removed using methods approved by the Engineer. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means shall be removed.

When suitable topsoil is available on the site, the Contractor shall remove this material from the designated areas and to the depth as directed by the Engineer. The topsoil shall be spread on areas already tilled and smooth-graded, or stockpiled in areas approved by the Engineer. Any topsoil stockpiled by the Contractor shall be rehandled and placed without additional compensation. Any topsoil that has been stockpiled on the site by others, and is required for topsoiling purposes, shall be removed and placed by the Contractor. The sites of all stockpiles and areas adjacent thereto which have been disturbed by the Contractor shall be graded if required and put into a condition acceptable for seeding.

When suitable topsoil is secured off the airport site, the Contractor shall locate and obtain the supply, subject to the approval of the Engineer. The Contractor shall notify the Engineer sufficiently in advance of operations in order that necessary measurements and tests can be made. The Contractor shall remove the topsoil from approved areas and to the depth as directed. The topsoil shall be hauled to the site of the work and placed for spreading, or spread as required. Any topsoil hauled to the site of the work and stockpiled shall be rehandled and placed without additional compensation.

**905-3.4 Placing topsoil.** The topsoil shall be evenly spread on the prepared areas to a uniform depth of 3 inches (75 mm) after compaction, unless otherwise shown on the plans or stated in the special provisions. Spreading shall not be done when the ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work. Spreading shall be carried on so that turfing operations can proceed with a minimum of soil preparation or tilling.

After spreading, any large, stiff clods and hard lumps shall be broken with a pulverizer or by other effective means, and all stones or rocks (2 inches (50 mm) or more in diameter), roots, litter, or any foreign matter shall be raked up and disposed of by the Contractor. After spreading is completed, the topsoil shall be satisfactorily compacted by rolling with a cultipacker or by other means approved by the Engineer. The compacted topsoil surface shall conform to the required lines, grades, and cross-sections. Any topsoil or other dirt falling upon pavements as a result of hauling or handling of topsoil shall be promptly removed.

**TESTING MATERIALS**

ASTM C117                      Materials Finer than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing

**END OF ITEM T-905**

## ITEM T-908 MULCHING

### DESCRIPTION

**908-1.1** This item shall consist of furnishing, hauling, placing, and securing mulch on surfaces indicated on the plans or designated by the Engineer.

### MATERIALS

**908-2.1 Mulch material.** Acceptable mulch shall be the materials listed below or any approved locally available material that is similar to those specified. Mulch shall be free from noxious weeds, mold, and other deleterious materials. Mulch materials, which contain matured seed of species that would volunteer and be detrimental to the proposed overseeding, or to surrounding farm land, will not be acceptable. Straw or other mulch material which is fresh and/or excessively brittle, or which is in such an advanced stage of decomposition as to smother or retard the planted grass, will not be acceptable.

**a. Manufactured mulch.** Cellulose-fiber or wood-pulp mulch shall be products commercially available for use in spray applications.

**b. Asphalt binder.** Asphalt binder material shall conform to the requirements of ASTM D977, Type SS-1 or RS-1.

**908-2.2 Inspection.** The Engineer shall be notified of sources and quantities of mulch materials available and the Contractor shall furnish him with representative samples of the materials to be used 30 days before delivery to the project. These samples may be used as standards with the approval of the Engineer and any materials brought on the site that do not meet these standards shall be rejected.

### CONSTRUCTION METHODS

**908-3.1 Mulching.** Before spreading mulch, all large clods, stumps, stones, brush, roots, and other foreign material shall be removed from the area to be mulched. Mulch shall be applied immediately after seeding. The spreading of the mulch may be by hand methods, blower, or other mechanical methods, provided a uniform covering is obtained.

Mulch material shall be furnished, hauled, and evenly applied on the area shown on the plans or designated by the Engineer. Straw or hay shall be spread over the surface to a uniform thickness at the rate of 2 to 3 tons per acre (1800 - 2700 kg per acre) to provide a loose depth of not less than 1-1/2 inches (38 cm) nor more than 3 inches (75 mm). Other organic material shall be spread at the rate directed by the Engineer. Mulch may be blown on the slopes and the use of cutters in the equipment for this purpose will be permitted to the extent that at least 95% of the mulch in place on the slope shall be 6 inches (150 mm) or more in length. When mulches applied by the blowing method are cut, the loose depth in place shall be not less than one inch (25 mm) nor more than 2 inches (50 mm).

**908-3.2 Securing mulch.** The mulch shall be held in place by light discing, a very thin covering of topsoil, pins, stakes, wire mesh, asphalt binder, or other adhesive material approved by the Engineer. Where mulches have been secured by either of the asphalt binder methods, it will not be permissible to walk on the slopes after the binder has been applied. When an application of asphalt binder material is used to secure the mulch, the Contractor must take every precaution to guard against damaging or disfiguring structures or property on or adjacent to the areas worked and will be held responsible for any such damage resulting from the operation.

If the “peg and string” method is used, the mulch shall be secured by the use of stakes or wire pins driven into the ground on 5-foot (1.5-m) centers or less. Binder twine shall be strung between adjacent stakes in straight lines and crisscrossed diagonally over the mulch, after which the stakes shall be firmly driven nearly flush to the ground to draw the twine down tight onto the mulch.

**908-3.3 Care and repair.**

**a.** The Contractor shall care for the mulched areas until final acceptance of the project. Care shall consist of providing protection against traffic or other use by placing warning signs, as approved by the Engineer, and erecting any barricades that may be shown on the plans before or immediately after mulching has been completed on the designated areas.

**b.** The Contractor shall be required to repair or replace any mulch that is defective or becomes damaged until the project is finally accepted. When, in the judgment of the Engineer, such defects or damages are the result of poor workmanship or failure to meet the requirements of the specifications, the cost of the necessary repairs or replacement shall be borne by the Contractor.

**c.** If the “asphalt spray” method is used, all mulched surfaces shall be sprayed with asphalt binder material so that the surface has a uniform appearance. The binder shall be uniformly applied to the mulch at the rate of approximately 8 gallons (32 liters) per 1,000 square feet (100 sq m), or as directed by the Engineer, with a minimum of 6 gallons (24 liters) and a maximum of 10 gallons (40 liters) per 1,000 square feet (100 sq m) depending on the type of mulch and the effectiveness of the binder securing it. Bituminous binder material may be sprayed on the mulched slope areas from either the top or the bottom of the slope. An approved spray nozzle shall be used. The nozzle shall be operated at a distance of not less than 4 feet (1.2 m) from the surface of the mulch and uniform distribution of the bituminous material shall be required. A pump or an air compressor of adequate capacity shall be used to ensure uniform distribution of the bituminous material.

**d.** If the “asphalt mix” method is used, the mulch shall be applied by blowing, and the asphalt binder material shall be sprayed into the mulch as it leaves the blower. The binder shall be uniformly applied to the mulch at the rate of approximately 8 gallons (32 liters) per 1,000 square feet (100 sq m) or as directed by the Engineer, with a minimum of 6 gallons (24 liters) and a maximum of 10 gallons (40 liters) per 1,000 square feet (100 sq m) depending on the type of mulch and the effectiveness of the binder securing it.

**MATERIAL REQUIREMENTS**

ASTM D977                      Standard Specification for Emulsified Asphalt

**END OF ITEM T-908**

## ITEM X-800 DEMOLITION AND REMOVAL

### DESCRIPTION

**800-1.1** This item shall consist of demolition and removal of existing items. The work shall be accomplished in accordance with these specifications and the applicable drawings.

### EQUIPMENT

**800-2.1** All equipment shall be specified here and in the following paragraphs or approved by the Engineer. The equipment shall not cause damage to the existing adjacent pavement or facilities to remain in place.

### CONSTRUCTION

**800-3.1 Removal of Asphalt and PCC Pavement.** The complete removal of pavement may be accomplished with any approved method. The ends of the removal area shall be clearly marked and saw cut (full depth) to provide a neat edge to butt up to the new pavement. Any areas outside of the construction area damaged by the Contractor shall be repaired at no cost to the project. The Contractor shall take care to not enlarge the area of removal beyond the marked boundary by using prudent construction practices. All removed Asphalt or PCC pavement shall be disposed of off-site at the contractor's expense.

**800-3.2 Sawcut of existing pavement.** The existing pavement shall be removed in accordance with X-800-3.1. Prior to removal, the asphalt concrete pavement to be removed shall be cut to the full depth of the bituminous material around the perimeter of the area to be removed. The pavement shall be removed so the joint for each layer of pavement replacement is offset 1 foot (30 cm) from the joint in the preceding layer. This does not apply if the removed pavement is to be replaced with concrete or soil. The contractor shall clean and/or remove all slurry and debris generated by the sawcut operation to the satisfaction of the Engineer. All material removed shall be disposed of off-site at the contractor's expense.

If during removal, pavement outside of the removal limits is damaged or spalls, the failed areas shall be removed. All failed material including surface, base course, subbase course, and subgrade shall be removed. The base course and subbase shall be replaced if it has been infiltrated with clay, silt, or other material affecting the load-bearing capacity. Materials and methods of construction shall comply with the other applicable sections of this specification. All work to repair damaged areas shall be done at the contractor's expense.

**800-3.3 Remove surface drainage trench.** The existing surface drainage trench. Removal shall include edging, soil/aggregate, geotextile or plastic layers, and all piping beyond the downspouts. All material removed shall be disposed of off-site at the Contractor's expense.

If during removal, pavement outside of the removal limits is damaged or spalls, the failed areas shall be removed. All failed material including surface, base course, subbase course, and subgrade shall be removed. The base course and subbase shall be replaced if it has been infiltrated with clay, silt, or other material affecting the load-bearing capacity. Materials and methods of construction shall comply with the other applicable sections of this specification. All work to repair damaged areas shall be done at the contractor's expense.

**END OF ITEM X-800**



**ITEM X-801 SUBBASE COURSE – STATE MIX CLASS II**

**DESCRIPTION**

**801-1.1** This item shall consist of a subbase course composed of granular materials constructed on a prepared subgrade or underlying course in accordance with these specifications, and in conformity with the dimensions and typical cross-section shown on the plans.

**MATERIALS**

**801-2.1 Materials.** The subbase material shall meet the physical material requirements of Section 902 in the 2012 Standard Specifications for Construction and this specification. This mixture must be uniform and shall comply with the requirements of these specifications as to gradation, soil constants, and shall be capable of being compacted into a dense and stable subbase. The material shall be free from vegetative matter, lumps or excessive amounts of clay, and other objectionable or foreign substances. Pit-run material may be used, provided the material meets the gradation requirements specified.

**Gradation Requirements**

Sieve designation (square openings) as per ASTM C136 and ASTM D422	Percentage by weight passing sieves
3 inch (75 mm)	100
1 inch (25.4 mm)	60-100
No. 4 (4.76 mm)	50-100
No. 100 (0.149 mm)	0-30
No. 200 (0.075 mm)	0-7

**801-2.2 Sampling and testing.** Material used on the project shall be sampled per ASTM D75 and tested per ASTM C136 and ASTM C117. Results shall be furnished to the Engineer by the Contractor prior to the start of construction and once during construction.

**CONSTRUCTION METHODS**

**801-3.1 General.** The subbase course shall be placed where designated on the plans or as directed by the Engineer. The material shall be shaped and thoroughly compacted within the tolerances specified.

Granular subbases which, due to grain sizes or shapes, are not sufficiently stable to support the construction equipment without movement, shall be mechanically stabilized to the depth necessary to provide stability as directed by the Engineer. The mechanical stabilization shall include the addition of a fine-grained medium to bind the particles of the subbase material sufficiently to furnish a bearing strength, so the course will not deform under construction equipment traffic. The addition of the binding medium to the subbase material shall not increase the soil constants of that material above the specified limits.

**801-3.2 Operation in pits.** The subbase material shall be obtained from pits or sources that have been approved by the Engineer. The material in the pits shall be excavated and handled to produce a uniform and satisfactory product. All work involved in clearing and stripping pits and handling unsuitable material encountered shall be performed by the Contractor. The cost of this work is incidental to this item.

**801-3.3 Preparing underlying course.** Prior to constructing the subbase course, clean the underlying course or subgrade of all foreign substances. The surface of the underlying course or subgrade shall meet specified compaction and surface tolerances. Correct ruts, or soft yielding spots, in the underlying courses and subgrade areas having inadequate compaction and deviations of the surface from the specified requirements by loosening and removing soft or unsatisfactory material and by adding approved material, reshaping to line and grade, and recompacting to specified density requirements. For cohesionless underlying courses or subgrades containing sands or gravels, as defined in ASTM D2487, the surface shall be stabilized prior to placement of the overlying course. Accomplish stabilization by mixing the overlying course material into the underlying course, and compacting by approved methods. The stabilized material shall be considered as part of the underlying course and shall meet all requirements for the underlying course. The finished underlying course shall not be disturbed by traffic or other operations and shall be maintained in a satisfactory condition until the overlying course is placed. The course shall be checked and accepted by the Engineer before placing and spreading operations are started.

To protect the subgrade and to ensure proper drainage, the spreading of the subbase shall begin along the centerline of the pavement on a crowned section or on the high side of pavements with a one-way slope.

**801-3.4 Materials acceptance in existing condition.** When the entire subbase material is in a uniform and satisfactory condition at approximately the required moisture content, the approved material may be moved directly to the spreading equipment for placing. The material may be obtained from gravel pits, stockpiles, or may be produced from a crushing and screening plant with proper blending. The materials from these sources shall meet the requirements for gradation, quality, and consistency. The intent of the specifications is to secure materials that will not require further mixing. The moisture content of the material shall be approximately that required to obtain maximum density. Any minor deficiency or excess in moisture content may be corrected by surface sprinkling or by aeration. Some mixing or aeration may be required prior to rolling to obtain the required moisture content. Blading or dragging, if necessary, shall be performed to obtain a smooth uniform surface true to line and grade.

**801-3.5 Plant mixing.** When materials from several sources will be blended and mixed, the subbase material shall be processed in a central mixing plant. The subbase material, together with any blended material, shall be thoroughly mixed with the required amount of water. After the mixing is complete, the material shall be transported to and spread on the underlying course without undue loss of moisture content.

**801-3.6 General methods for placing.** The subbase course shall be constructed in layers of not more than 15 inches of compacted thickness. The subbase material shall be deposited and spread evenly to a uniform thickness and width. The material, as spread, shall be of uniform gradation with no pockets of fine or coarse materials. The subbase, unless otherwise permitted by the Engineer, shall not be spread more than 2,000 square yards (1700 sq m) in advance of the rolling. Any necessary sprinkling shall be kept within this limit. No material shall be placed in snow or on a soft, muddy, or frozen course.

When more than one layer is required, the construction procedure described here shall apply similarly to each layer.

During the placing and spreading, sufficient caution shall be exercised to prevent the incorporation of subgrade, shoulder, or foreign material in the subbase course mixture.

**801-3.7 Finishing and compacting.** After spreading or mixing, the subbase material shall be thoroughly compacted by rolling and sprinkling, when necessary. Sufficient rollers shall be furnished to adequately handle the rate of placing and spreading of the subbase course.

The field density of the compacted material shall be at least 95% of the maximum density of laboratory specimens prepared from samples of the subbase material delivered to the jobsite. The laboratory specimens shall be compacted and tested in accordance with ASTM D698. The in-place field density shall be determined in accordance with ASTM D6938 using Procedure A, the direct transmission method, and

ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. The moisture content of the material at the start of compaction shall be within  $\pm 2\%$  of the optimum moisture content. The Contractor's laboratory shall perform all density tests and provide the test results upon completion daily to the Engineer for acceptance.

The course shall not be rolled when the underlying course is soft or yielding or when the rolling causes undulation in the subbase. When the rolling develops irregularities that exceed  $3/8$  inch (9 mm) when tested with a 12 feet (3.7 m) straightedge, the irregular surface shall be loosened and then refilled with the same kind of material as that used in constructing the course and again rolled as required above.

Along places inaccessible to rollers, the subbase material shall be tamped thoroughly with mechanical or hand tampers.

Sprinkling during rolling, if necessary, shall be by equipment approved by the Engineer. Water shall not be added in manner or quantity that allows free water to reach the underlying layer and cause it to become soft.

**801-3.8 Acceptance sampling and testing for density.** Subbase course shall be accepted for density on a lot basis. A lot will consist of one day's production where it is not expected to exceed 2,400 square yards per lift.

Each lot shall be divided into two equal sublots. One test shall be made for each subplot. Sampling locations will be determined by the Engineer on a random basis in accordance with statistical procedures contained in ASTM D3665.

If the specified density is not attained, the entire lot shall be reworked and/or recompacted and two additional random tests made. This procedure shall be followed until the specified density is reached.

**801-3.9 Surface tolerance.** The surface of the top layer shall show no deviations in excess of  $3/8$  inch (9 mm) when tested with a 12-foot (3.7-m) straightedge. Take measurements in successive positions parallel to the centerline of the area to be paved. Measurements shall also be taken perpendicular to the centerline at 50-foot intervals. Correct deviations exceeding this amount by removing material and replacing with new material, or by reworking existing material and compacting it to meet these specifications.

**801-3.10 Thickness control.** The completed thickness of the course(s) shall be in accordance with the thickness and grade indicated on the drawings. The completed course shall not be more than  $1/2$  inch (12 mm) deficient in thickness nor more than  $1/2$  inch (12 mm) above or below the established grade. Where any of these tolerances are exceeded, correct such areas by scarifying, adding new material of proper gradation or removing material, and compacting, as directed. Where the measured thickness is  $1/2$  inch (12 mm) or thicker than shown, the course will be considered as conforming with the specified thickness requirements plus  $1/2$  inch (12 mm). The average job thickness shall be the average of the job measurements as specified above but within  $1/4$  inch (6 mm) of the thickness shown. The thickness of the completed subbase course shall be determined by survey.

**801-3.11 Protection.** Work on subbase course shall not be conducted during freezing temperatures nor when the subgrade is wet. When the subbase material contains frozen material or when the underlying course is frozen, the construction shall be stopped. The Contractor shall protect and maintain the subgrade from yielding until the subbase is accepted.

**801-3.12 Maintenance.** The Contractor shall maintain the completed course in a satisfactory condition until accepted by the Engineer.

**TESTING REQUIREMENTS**

ASTM C117	Standard Test Method for Materials Finer Than 75- $\mu\text{m}$ (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D422	Standard Test Method for Particle-Size Analysis of Soils
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft <sup>3</sup> (600 kN-m/m <sup>3</sup> ))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft <sup>3</sup> (2,700 kN-m/m <sup>3</sup> ))
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
ASTM D4253	Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table
ASTM D4318	Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
ASTM D4718	Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

**END OF ITEM X-801**

**ITEM X-802 AGGREGATE BASE COURSE – STATE MIXES**

**DESCRIPTION**

**802-1.1** This item consists of a base course composed of crushed aggregate base constructed on a prepared course in accordance with these specifications and in conformity to the dimensions and typical cross-sections shown on the plans.

**MATERIALS**

**802-2.1 Aggregate base** Aggregate shall meet the physical material requirements of Section 902 in the 2012 Standard Specifications for Construction and this specification. All aggregates shall consist of clean, sound, durable particles and shall be free from coatings of clay, silt, organic material, or other objectionable materials. Aggregates shall contain no clay lumps or balls. If necessary, combine fine aggregate with natural aggregate, iron blast furnace slag, reverberatory slag or crushed concrete aggregate blend in accordance with table 802-1 and 802-2.

Ensure aggregate produced from crushing Portland cement concrete does not contain more than 5.0 percent building rubble or hot mix asphalt by particle. Building rubble is defined as building brick, wood, plaster, or other material.

The final aggregate blend shall have a LA Abrasion max % of 50 and a crushed material percent of at least 95.

**a. Sampling and testing for initial aggregate base requirements.** Samples shall be taken by the Contractor in the presence of the Engineer. Material shall meet the requirements in paragraph 802-2.1. This sampling and testing will be the basis for approval of the aggregate base quality requirements.

**802-2.2 Gradation requirements.** The gradation of the aggregate base material shall meet the requirements of the gradation given in the following table.

**Gradation Requirements**

Sieve designation (square openings) as per ASTM C136 and ASTM D422	Percentage by weight passing sieves
1 1/2 inch (38.1 mm)	100
1 inch (25.4 mm)	85-100
½ inch (12.7 mm)	50-75
No. 8 (2.38 mm)	20-45
No. 200 (0.075 mm)	4-8

**a. Sampling and testing for gradation.** Gradation tests shall be performed by the Contractor per ASTM C136 and sieve analysis on material passing the No. 200 sieve (75 mm) per ASTM C112. The Contractor shall take at least one aggregate base sample per lot to check the final gradation. Sampling shall be per ASTM D75. The lot will be consistent with the lot size used for density. The samples shall be taken from the in-place, un-compacted material in the presence of the Engineer. Sampling points and intervals will be designated by the Engineer.

## CONSTRUCTION METHODS

**802-3.1 Preparing underlying subgrade and/or subbase.** Re-proof rolling of the subgrade or proof rolling of the subbase in accordance with P-152, at the Contractor's expense, may be required by the Engineer if the Contractor fails to ensure proper drainage or protect the subgrade and/or subbase. Any ruts or soft, yielding areas due to improper drainage conditions, hauling, or any other cause, shall be corrected before the base course is placed. To ensure proper drainage, the spreading of the base shall begin along the centerline of the pavement on a crowned section or on the high side of the pavement with a one-way slope.

**802-3.2 Production.** The aggregate shall be uniformly blended and, when at a satisfactory moisture content per paragraph 802-3.4, the approved material may be transported directly to the spreading equipment.

**802-3.3 Placing.** The aggregate base material shall be placed on the prepared underlying subgrade and/or subbase and compacted in layers to the thickness shown on the plans. Work shall progress without interruption. The material shall be deposited and spread in lanes in a uniform layer without segregation to such loose depth that, when compacted, the layer shall have the specified thickness. The aggregate base course shall be constructed in layers of uniform thickness of not greater than 6 inches. The aggregate as spread shall be of uniform grading with no pockets of fine or coarse materials. The aggregate, unless otherwise permitted by the Engineer, shall not be spread more than 2,000 square yards (1700 sq m) in advance of the rolling. Any necessary sprinkling shall be kept within these limits. Care shall be taken to prevent cutting into the underlying layer during spreading. No material shall be placed in snow or on a soft, muddy, or frozen course. The aggregate base material shall be spread by spreader boxes or other approved devices. This equipment shall have positive thickness controls that spread the aggregate in the required amount to avoid or minimize the need for hand manipulation. Dumping from vehicles that require re-handling shall not be permitted. Hauling over the uncompacted base course shall not be permitted.

When more than one layer is required, the construction procedure described herein shall apply similarly to each layer.

**802-3.4 Compaction.** Immediately after completion of the spreading operations, compact each layer of the base course, as specified, with approved compaction equipment. The number, type, and weight of rollers shall be sufficient to compact the material to the required density within the same day that the aggregate is placed on the subgrade. The moisture content of the material during placing operations shall be within  $\pm 2$  percentage points of the optimum moisture content as determined by ASTM D6938 using Procedure A, the direct transmission method and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated per ASTM D6938.

**802-3.5 Acceptance sampling and testing for density.** Aggregate base course shall be accepted for density on a lot basis. A lot will consist of one day's production if it does not exceed 2,400 square yards (2000 sq m). A lot will consist of one-half day's production if a day's production consists of between 2,400 and 4,800 square yards (2000 and 4000 sq m). The Contractor's laboratory shall perform all density tests and provide the test results upon completion daily to the Engineer for acceptance.

Each lot shall be divided into two equal sublots. One test shall be made for each subplot and shall consist of the average of two random locations for density determination. Sampling locations will be determined by the Engineer on a random basis per ASTM D3665.

Each lot will be accepted for density when the field density is at least 98% of the maximum density of laboratory specimens. The specimens shall be compacted and tested per ASTM D698. The in-place field density shall be determined per ASTM D6938 using Procedure A, the direct transmission method, and ASTM D6938 shall be used to determine the moisture content of the material. The machine shall be calibrated in accordance with ASTM D6938. If the specified density is not attained, the entire lot shall be reworked and/or recompacted and two additional random tests made at the Contractor's expense. This procedure shall be followed until the specified density is reached.

**802-3.6 Surface tolerances.** After the course has been compacted, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and recompacted to grade. until the required smoothness and accuracy are obtained and approved by the Engineer. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor’s expense. The smoothness and accuracy requirements specified here apply only to the top layer when base course is constructed in more than one layer.

**a. Smoothness.** The finished surface shall not vary more than 3/8 inch (9 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.

**b. Accuracy.** The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within +0 and -1/2 inch (12 mm) of the specified grade.

**802-3.7 Thickness control.** The completed thickness of the base course shall be within +0 and -1/2 inch (12 mm) of the specified thickness and grade indicated on the drawings. as determined by depth tests taken by the Contractor in the presence of the Engineer. Where any of these tolerances are exceeded, correct such areas by scarifying, adding new material of proper gradation or removing material, and compacting, as directed. The contractor shall correct such areas at no additional cost.

**802-3.8 Protection.** Perform construction when the atmospheric temperature is above 35°F (2°C). When the temperature falls below 35°F (2°C), protect all completed areas by approved methods against detrimental effects of freezing. Correct completed areas damaged by freezing, rainfall, or other weather conditions to meet specified requirements. When the aggregates contain frozen materials or when the underlying course is frozen or wet, the construction shall be stopped. Hauling equipment may be routed over completed portions of the base course, provided no damage results. Equipment shall be routed over the full width of the base course to avoid rutting or uneven compaction. The Engineer will stop all hauling over completed or partially completed base course when, in the Engineer’s opinion, such hauling is causing damage. Any damage to the base course shall be repaired by the Contractor at the Contractor’s expense.

**802-3.9 Maintenance.** The Contractor shall maintain the base course in a satisfactory condition until the full pavement section is completed and accepted by the Engineer. The surface shall be kept clean and free from foreign material and properly drained at all times. Maintenance shall include immediate repairs to any defects and shall be repeated as often as necessary to keep the area intact. Any base course that is not paved over prior to the onset of winter shall be retested to verify that it still complies with the requirements of this specification. Any area of base course that is damaged shall be reworked or replaced as necessary to comply with this specification.

Equipment used in the construction of an adjoining section may be routed over completed base course, if no damage results and the equipment is routed over the full width of the base course to avoid rutting or uneven compaction.

The Contractor shall remove all survey and grade hubs from the base courses prior to placing any bituminous surface course.

**TESTING REQUIREMENTS**

ASTM C29	Standard Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate

ASTM C117	Standard Test Method for Materials Finer than 75- $\mu\text{m}$ (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM D75	Standard Practice for Sampling Aggregates
ASTM D422	Standard Test Method for Particle-Size Analysis of Soils
ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft <sup>3</sup> (600 kN-m/m <sup>3</sup> ))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft <sup>3</sup> (2700 kN-m/m <sup>3</sup> ))
ASTM D2167	Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D4718	Standard Practice for Correction of Unit Weight and Water Content for Soils Containing Oversize Particles
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM D5821	Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

**END OF ITEM X-802**



**ITEM X-803 HOT MIX ASPHALT – STATE MIXES**

**DESCRIPTION**

**803-1.1** This item shall consist of pavement courses composed of mineral aggregate and asphalt cement binder (asphalt binder) mixed in a central mixing plant and placed on a prepared course in accordance with these specifications and shall conform to the lines, grades, thicknesses, and typical cross-sections shown on the plans. Each course shall be constructed to the depth, typical section, and elevation required by the plans and shall be rolled, finished, and approved before the placement of the next course.

**EQUIPMENT AND MATERIALS**

**803-2.1 Aggregate.** Coarse and Fine Aggregate shall meet the physical material requirements of Section 902 in the 2012 Standard Specifications for Construction and this specification. All aggregate shall be clean, hard, durable, uncoated and free of clay lumps, organic matter, soft or flakey material and other foreign matter.

Coarse Aggregate shall be natural aggregate, iron blast furnace slag, reverberatory furnace slag, steel furnace slag, crushed concrete.

Fine Aggregate shall be natural aggregate, iron blast furnace slag, reverberatory furnace slag, steel furnace slag, manufactured fine aggregate, or a uniformly graded blend as fine aggregate.

The final aggregate blend shall meet the following physical requirements:

**Table 801-1 Final Aggregate Blend Physical Requirements**

Mix Type	Fine Aggregate Angularity Min.		% Sand Equivalent Min.		LA Abrasion % Loss Min.		% Soft Particles Max. (a)		% Flat and Elongated Max. (b)	
	Top & Leveling Courses	Base Course	Top & Leveling Courses	Base Course	Top & Leveling Courses	Base Course	Top & Leveling Courses	Base Course	Top & Leveling Courses	Base Course
LSVP	--	--	40	40	45	45	10	10	--	--
E03	--	--	40	40	45	45	10	10	--	--
E1	40	--	40	40	40	45	10	10	--	--
E3	40	40	40	40	35	4	5	5	10	10
E10	45	40	45	45	35	40	5	5	10	10
E30	45	40	45	45	35	35	3	4.5	10	10
E50	54	45	50	50	35	35	3	4.5	10	10

a. Soft particles maximum is the sum of the shale, siltstone, ochre, coal, clay-ironstone, and particles that are structurally weak or are non-durable in service.  
 b. Maximum by weight with a 1:5 aspect ratio

**803-2.2 Mineral filler.** If filler, in addition to that naturally present in the aggregate, is necessary, it shall be 3MF mineral filler consisting of limestone dust, dolomite dust, fly ash collected by an electrostatic precipitation method, slag, or hydrated lime with 100% passing the No. 200 sieve, Mineral filler must be from MDOT approved source. The free carbon content of the fly ash sample must not exceed 12% by weight as measured by the loss on ignition test in accordance with ASTM C311.

**803-2.3 Tack Coat.** Shall be in accordance specifications P-603 and shall be incidental to this item.

**803-2.4 Asphalt cement binder.** Asphalt cement binder shall conform to ASTM D6373 Performance Grade (PG) 64-28. A certificate of compliance from the manufacturer shall be included with the mix design submittal.

**803-2.5 Preliminary material acceptance.** Prior to delivery of materials to the job site, the Contractor shall submit certified test reports to the Engineer for the following materials:

**a. Combined Aggregates:**

- (1) Fine aggregate Angularity
- (2) Sand equivalent
- (3) LA abrasion
- (4) Soft particles
- (5) Flat and elongated particles

**COMPOSITION**

**803-3.1 Mix Design.** No hot-mixed asphalt (HMA) for payment shall be produced until a Job Mix Formula (JMF) has been approved in writing by the Engineer. Composition and facilities shall meet the requirements of Section 501 in the 2012 Standard Specifications for Construction and this specification.

The JMF shall be submitted in writing by the Contractor at least 30 days prior to the start of paving operations. The JMF shall be developed within the same construction season using aggregates currently being produced.

The submitted JMF shall be stamped or sealed by the responsible professional Engineer of the laboratory and shall include the following items as a minimum:

- a. Percent passing each sieve size for total combined gradation, individual gradation of all aggregate stockpiles and percent by weight of each stockpile used in the job mix formula.
- b. Percent of asphalt cement.
- c. Asphalt performance grade and type of modifier if used.
- d. Number of Gyration
- e. Percent of max. specific gravity ( $\%G_{mm}$ ) at the design number of gyrations ( $N_d$ )
- f.  $\%G_{mm}$  at initial number of gyrations ( $N_i$ )
- g.  $\%G_{mm}$  at maximum number of gyrations ( $N_m$ )
- h. VMA min % at  $N_d$
- i. VFA at  $N_d$
- j. Fines to effective asphalt binder ( $P_{NO200}/P_{be}$ )
- k. Tensile Strength Ratio (TSR).
- l. Date the JMF was developed.

The Contractor may use mix designs approved by MDOT on other projects, if approved by the Engineer. When the project requires asphalt mixtures of differing aggregate gradations, a separate JMF and the results of JMF verification testing shall be submitted for each mix.

The JMF for each mixture shall be in effect until a modification is approved in writing by the Engineer. Should a change in sources of materials be made, a new JMF must be submitted within 15 days and approved by the Engineer in writing before the new material is used. After the initial production JMF has been approved by the Engineer and a new or modified JMF is required for whatever reason, the subsequent cost of the Engineer’s approval of the new or modified JMF, including a new test strip when required by the engineer, will be borne by the Contractor. There will be no time extension given or considerations for extra costs associated with the stoppage of production paving or restart of production paving due to the time needed for the Engineer to approve the initial, new or modified JMF.

Mix designs shall meet the requirements of Tables 801-2, 801-3, 801-4, and 801-5.

<b>Table 801-2 Superpave Final Aggregate Blend Gradation Requirements</b>					
<b>Standard Sieve</b>	<b>Percent Passing (control points)</b>				
	<b>Mixture Number</b>				
	<b>5</b>	<b>4</b>	<b>3</b>	<b>2</b>	<b>LVSP (a)</b>
1 ½”	--	--	--	100	--
1”	--	--	100	90 – 100	--
¾”	--	100	90 – 100	≤ 90	100
½”	100	90 – 100	≤ 90	--	75 – 95
3/8”	90 – 100	≤ 90	--	--	60 – 90
No. 4	≤ 90	--	--	--	45 – 80
No. 8	32 – 67	28 – 58	23 – 49	19 – 45	30 – 65
No. 16	--	--	--	--	20 – 50
No. 30	--	--	--	--	15 – 40
No. 50	--	--	--	--	10 – 25
No. 100	--	--	--	--	5 – 15
No. 200	2.0 – 10.0	2.0 – 10.0	2.0 – 8.0	1.0 – 7.0	3 – 6
<b>Sieve</b>	<b>Restricted Zone (b,c)</b>				
No. 4	--	--	--	39.5	(d)
No. 8	47.2	39.1	34.6	26.8 – 30.8	(d)
No. 16	31.6 - 37.6	25.6 – 31.6	22.3 – 28.3	18.1 – 24.1	(d)
No. 30	23.5 – 27.5	19.1 – 23.1	16.7 – 20.7	13.6 – 20.7	(d)
No. 50	18.7	15.5	13.7	11.4	(d)
a. For LVSP, less than 50% of the material passing the No. 4 sieve may pass the No. 30 sieve. b. The final gradation blend must pass between control points established. The following conditions must be satisfied in order for the final gradation blend to enter the restricted zone. c. Mixture types E03, E1, E3, E10, E30, and E50 may enter the restricted zone provided the final gradation blend enters from above the maximum density line. d. Restricted zone does not apply to LVSP					

**Table 801-3 Superpave Mix Design Criteria**

Design Parameter	Mix Number				
	5	4	3	2	LVSP
Target Air Voids	4%				
Percent Maximum Specific Gravity (%G <sub>mm</sub> ) at the design number of gyrations (N <sub>d</sub> ) (c)	96.0% (a)				
%G <sub>mm</sub> at the initial number of gyrations (N <sub>i</sub> )	See Table 801-4				
%G <sub>mm</sub> at the maximum number of gyrations (N <sub>m</sub> )	98.0%				
VMA min % ad N <sub>d</sub>	15.00	14.00	13.00	12.00	14.00
VFA at N <sub>d</sub>	See Table 801-3 (b)				
Fines to effective asphalt binder (P <sub>NO200</sub> /P <sub>be</sub> )	0.6-1.2				
Tensile Strength Ratio (TSR)	80% min.				
a. For mixtures meeting the definition for base course, design mixtures to 96.0% of %G <sub>mm</sub> at N <sub>d</sub> . During field production, increase %G <sub>mm</sub> at N <sub>d</sub> to 97.0% b. For base or regressed shoulder mixtures, the maximum criteria do not apply c. Lower target airvoids by 1.0% if used in a separate shoulder paving operation, unless otherwise shown on the plans					

**Table 801-4 Superpave VFA Minimum and Maximum**

Mix Type	Top & Leveling Courses, %	Base Course, %
LSVP	70 – 80	70 – 80
E03	70 – 80	70 – 80
E1	65 – 78	65 – 78
E3	65 – 78	65 – 78
E10	65 – 78 (a)	65 – 75
E30	65 – 78 (a)	65 – 75
E50	65 – 78 (a)	65 – 75
a. The specified VFA range for mix Number 5 is 73% - 76%		

**Table 801-5 Superpave Gyrotory Compactor (SGC) Compaction**

Mix Type	%G <sub>mm</sub> at N <sub>i</sub>	Number of Gyrations (a)		
		N <sub>i</sub>	N <sub>d</sub>	N <sub>m</sub>
LSVP	91.5%	6	45	70
E03	91.5%	7	50	75
E1	90.5 %	7	76	117
E3	90.5%	7	86	134
E10	89.0%	8	96	152
E30	89.0%	8	109	174
E50	89.0%	9	126	204
a. Compact mix specimens fabricated in the SGC to N <sub>d</sub> . Use height data provided by SGC to calculate volumetric properties at N <sub>i</sub> . Compact mix specimens at optimum P <sub>b</sub> to verify N <sub>m</sub> for mix design specimens only.				

## CONSTRUCTION METHODS

**803-4.1 Weather limitations.** The HMA shall not be placed upon a wet surface or when the surface temperature of the underlying course is less than specified in Table 801-5. The temperature requirements may be waived by the Engineer, if requested; however, all other requirements including compaction shall be met.

**Table 801-6 Surface Temperature Limitations of Underlying Course**

Mat Thickness	Base Temperature (Minimum)	
	°F	°C
3 inches (7.5 cm) or greater	40	4
Greater than 2 inches (50 mm) but less than 3 inches (7.5 cm)	45	7

**803-4.2 HMA plant.** Plants used for the preparation of HMA shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M156 with the following changes:

**a. Truck scales.** The HMA shall be weighed on approved scales furnished by the Contractor, or on certified public scales at the Contractor's expense. Scales shall be inspected and sealed as often as the Engineer deems necessary to assure their accuracy. Scales shall conform to the requirements of the General Provisions, subsection 90-01.

In lieu of scales, and as approved by the Engineer, HMA weight may be determined by the use of an electronic weighing system equipped with an automatic printer that weighs the total HMA production and as often thereafter as requested by the Engineer.

**b. Inspection of plant.** The Engineer, or Engineer's authorized representative, shall have access, at all times, to all areas of the plant for checking adequacy of equipment; inspecting operation of the plant; verifying weights, proportions, and material properties; and checking the temperatures maintained in the preparation of the mixtures.

**c. Storage bins and surge bins.** The HMA stored in storage and surge bins shall meet the same requirements as HMA loaded directly into trucks and may be permitted under the following conditions:

- (1) Stored in non-insulated bins for a period of time not to exceed three (3) hours.
- (2) Stored in insulated bins for a period of time not to exceed eight (8) hours.

**803-4.3 Hauling equipment.** Trucks used for hauling HMA shall have tight, clean, and smooth metal beds. To prevent the HMA from sticking to the truck beds, the truck beds shall be lightly coated with a minimum amount of paraffin oil, lime solution, or other material approved by the Engineer. Petroleum products shall not be used for coating truck beds. Each truck shall have a suitable cover to protect the mixture from adverse weather. When necessary, to ensure that the mixture will be delivered to the site at the specified temperature, truck beds shall be insulated or heated and covers shall be securely fastened.

**803-4.4 HMA pavers.** HMA pavers shall be self-propelled with an activated heated screed, capable of spreading and finishing courses of HMA that will meet the specified thickness, smoothness, and grade. The paver shall have sufficient power to propel itself and the hauling equipment without adversely affecting the finished surface.

The paver shall have a receiving hopper of sufficient capacity to permit a uniform spreading operation. The hopper shall be equipped with a distribution system to place the HMA uniformly in front of the screed without segregation. The screed shall effectively produce a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture.

If, during construction, it is found that the spreading and finishing equipment in use leaves tracks or indented areas, or produces other blemishes in the pavement that are not satisfactorily corrected by the scheduled operations, the use of such equipment shall be discontinued and satisfactory equipment shall be provided by the Contractor.

**803-4.4.1 Automatic grade controls.** The HMA paver shall be equipped with a control system capable of automatically maintaining the specified screed elevation. The control system shall be automatically actuated from either a reference line and/or through a system of mechanical sensors or sensor-directed mechanisms or devices that will maintain the paver screed at a predetermined transverse slope and at the proper elevation to obtain the required surface. The transverse slope controller shall be capable of maintaining the screed at the desired slope within  $\pm 0.1\%$ .

The controls shall be capable of working in conjunction with any of the following attachments:

- a. Ski-type device of not less than 30 feet (9 m) in length.
- b. Taut string-line (wire) set to grade.
- c. Short ski or shoe.
- d. Laser control.

**803-4.5 Rollers.** Rollers of the vibratory, steel wheel, and pneumatic-tired type shall be used. They shall be in good condition, capable of operating at slow speeds to avoid displacement of the HMA. The number, type, and weight of rollers shall be sufficient to compact the HMA to the required density while it is still in a workable condition.

All rollers shall be specifically designed and suitable for compacting HMA concrete and shall be properly used. Rollers that impair the stability of any layer of a pavement structure or underlying soils shall not be used. Depressions in pavement surfaces caused by rollers shall be repaired by the Contractor at their own expense.

The use of equipment that causes crushing of the aggregate will not be permitted

**803-4.6. Density device.** The Contractor shall have on site a density gauge during all paving operations in order to assist in the determination of the optimum rolling pattern, type of roller and frequencies, as well as to monitor the effect of the rolling operations during production paving. The Contractor shall also supply a qualified technician during all paving operations to calibrate the gauge and obtain accurate density readings for all new HMA. These densities shall be supplied to the Engineer upon request at any time during construction. No separate payment will be made for supplying the density gauge and technician.

**803-4.7 Preparation of the underlying surface.** Immediately before placing the HMA, the underlying course shall be cleaned of all dust and debris. A tack coat shall be applied in accordance with Item P-603, if shown on the plans.

**803-4.8 Laydown plan, transporting, placing, and finishing.** Prior to the placement of the HMA, the Contractor shall prepare a laydown plan for approval by the Engineer. This is to minimize the number of cold joints in the pavement. The laydown plan shall include the sequence of paving laydown by stations, width of lanes, temporary ramp locations, and laydown temperature. The laydown plan shall also include estimated time of completion for each portion of the work (that is, milling, paving, rolling, cooling, etc.). Modifications to the laydown plan shall be approved by the Engineer.

The HMA shall be transported from the mixing plant to the site in vehicles conforming to the requirements of paragraph 801-4.3. Deliveries shall be scheduled so that placing and compacting of HMA is uniform with minimum stopping and starting of the paver. Hauling over freshly placed material shall not be permitted until the material has been compacted, as specified, and allowed to cool to atmospheric temperature.

The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose for the first lift of all runway and taxiway pavements. Successive lifts of HMA surface course may be placed using a ski, or laser control per paragraph 801-4.4.1.

The initial placement and compaction of the HMA shall occur at a temperature suitable for obtaining density, surface smoothness, and other specified requirements but not less than 250°F (121°C).

Edges of existing HMA pavement abutting the new work shall be saw cut and carefully removed as shown on the drawings and coated with asphalt tack coat before new material is placed against it.

Upon arrival, the HMA shall be placed to the full width by a HMA paver. It shall be struck off in a uniform layer of such depth that, when the work is completed, it shall have the required thickness and conform to the grade and contour indicated. The speed of the paver shall be regulated to eliminate pulling and tearing of the HMA mat. Unless otherwise permitted, placement of the HMA shall begin along the centerline of a crowned section or on the high side of areas with a one-way slope. The HMA shall be placed in consecutive adjacent strips having a minimum width of 12.5' feet except where edge lanes require less width to complete the area. Additional screed sections shall not be attached to widen paver to meet the minimum lane width requirements specified above unless additional auger sections are added to match. The longitudinal joint in one course shall offset the longitudinal joint in the course immediately below by at least 1 foot (30 cm); however, the joint in the surface top course shall be at the centerline of crowned pavements. Transverse joints in one course shall be offset by at least 10 feet from transverse joints in the previous course.

Transverse joints in adjacent lanes shall be offset a minimum of 10 feet.

On areas where irregularities or unavoidable obstacles make the use of mechanical spreading and finishing equipment impractical, the HMA may be spread and luted by hand tools.

Areas of segregation in the surface course, as determined by the Engineer, shall be removed and replaced at the Contractor's expense. The area shall be removed by saw cutting and milling a minimum of 2 inches deep. The area to be removed and replaced shall be a minimum width of the paver and a minimum of 10 feet long.

**803-4.9 Compaction of HMA.** After placing, the HMA shall be thoroughly and uniformly compacted by power rollers. The surface shall be compacted as soon as possible when the HMA has attained sufficient stability so that the rolling does not cause undue displacement, cracking or shoving. The sequence of rolling operations and the type of rollers used shall be at the discretion of the Contractor. The speed of the roller shall, at all times, be sufficiently slow to avoid displacement of the hot mixture and be effective in compaction. Any displacement occurring as a result of reversing the direction of the roller, or from any other cause, shall be corrected at once.

Sufficient rollers shall be furnished to handle the output of the plant. Rolling shall continue until the surface is of uniform texture, true to grade and cross-section, and the required field density is obtained. To prevent adhesion of the HMA to the roller, the wheels shall be equipped with a scraper and kept properly moistened but excessive water will not be permitted.

In areas not accessible to the roller, the mixture shall be thoroughly compacted with approved power driven tampers. Tampers shall weigh not less than 275 pounds (125 kg), have a tamping plate width not less than 15 inches (38 cm), be rated at not less than 4,200 vibrations per minute, and be suitably equipped with a standard tamping plate wetting device.

Any HMA that becomes loose and broken, mixed with dirt, contains check-cracking, or in any way defective shall be removed and replaced with fresh hot mixture and immediately compacted to conform to the surrounding area. This work shall be done at the Contractor's expense. Skin patching shall not be allowed.

**803-4.10 Joints.** The formation of all joints shall be made in such a manner as to ensure a continuous bond between the courses and obtain the required density. All joints shall have the same texture as other sections of the course and meet the requirements for smoothness and grade.

The roller shall not pass over the unprotected end of the freshly laid HMA except when necessary to form a transverse joint. When necessary to form a transverse joint, it shall be made by means of placing a bulkhead or by tapering the course. The tapered edge shall be cut back to its full depth and width on a straight line to expose a vertical face prior to placing the adjacent lane. In both methods, all contact surfaces shall be coated with an asphalt tack coat before placing any fresh HMA against the joint.

Longitudinal joints which have been left exposed for more than four (4) hours; the surface temperature has cooled to less than 175°F (80°C); or are irregular, damaged, uncompacted or otherwise defective shall be cut back 3 inches (75 mm) to expose a clean, sound, uniform vertical surface for the full depth of the course. All cutback material shall be removed from the project. The contractor shall not receive payment for the material cutback and removed. Asphalt tack coat or other product approved by the Engineer shall be applied to the clean, dry joint, prior to placing any additional fresh HMA against the joint. Any laitance produced from cutting joints shall be removed by vacuuming and washing. The cost of this work shall be considered incidental to the cost of the HMA.

## MATERIAL ACCEPTANCE

**803-5.1 Acceptance sampling and testing.** Unless otherwise specified, all acceptance sampling and testing necessary to determine conformance with the requirements specified in this section will be performed by the Contractor at their own expense. Test reports shall be submitted to the Engineer for review no later than 24 hours after each day's paving is completed.

**a. Hot mixed asphalt.** Plant-produced HMA shall be tested on a lot basis. Sampling shall be from material deposited into trucks at the plant or from trucks at the job site. Samples shall be taken in accordance with ASTM D979.

A standard lot shall be equal to one day's production or 2000 tons whichever is smaller. If the day's production is expected to exceed 2000 tons, but less than 4000 tons, the lot size shall be 1/2 day's production. If the day's production exceeds 4000 tons, the lot size shall be an equal sized fraction of the day's production, but shall not exceed 2000. Where more than one plant is simultaneously producing HMA for the job, the lot sizes shall apply separately for each plant.

**(1) Sampling.** Each lot for plant produced HMA will consist of two equal sublots. Sufficient HMA for preparation of test specimens for all testing will be sampled by the Contractor on a random basis, in accordance with the procedures contained in ASTM D3665. Samples will be taken in accordance with ASTM D979.

The sample of HMA may be put in a covered metal tin and placed in an oven for not less than 30 minutes nor more than 60 minutes to stabilize to compaction temperature. The compaction temperature of the specimens shall be as specified in the JMF.

**(2) Testing.** Once per subplot the Contractor will test the following criteria;

- a. Asphalt Cement Content (ASTM D2172)
- b. HMA gradation (ASTM D5444)



**b. In-place HMA.** HMA placed in the field shall be tested for mat and joint density on a lot basis. A standard lot shall be equal to one day’s production or 2000 tons whichever is smaller. If the day’s production is expected to exceed 2000, but less than 4000 tons, the lot size shall be 1/2 day’s production. If the day’s production exceeds 4000 tons, the lot size shall be an equal sized fraction of the day’s production, but shall not exceed 2000 tons.

**(1) Sampling.** Each lot for In-place HMA will consist of four equal sublots.

**(2) Testing.** One density test of compacted HMA shall be taken by the Contractor from each sublot. Density locations will be determined by the Engineer on a random basis in accordance with procedures contained in ASTM D3665. Density tests shall not be taken closer than one foot from a transverse or longitudinal joint.

**803-5.2 Acceptance criteria.**

**a. General.** Acceptance will be based on the following characteristics of the HMA and completed pavement:

- (1) Asphalt Cement Content**
- (2) Gradation**
- (3) Mat density**
- (4) Smoothness**

The Engineer may at any time, reject and require the Contractor to dispose of any batch of HMA which is rendered unfit for use due to contamination, segregation, incomplete coating of aggregate, or improper mix temperature. Such rejection may be based on only visual inspection or temperature measurements. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the Engineer, and if it can be demonstrated in the laboratory, in the presence of the Engineer, that such material was erroneously rejected, payment will be made for the material at the contract unit price.

**b. Acceptance criteria.**

**(1) Asphalt Cement content and gradation.** Acceptance of plant produced material for AC content and gradation shall be determined on a lot basis and will be based on the limits shown in Table 801-7:

Table 801-7 Uniformity Tolerance Limits for HMA Mixtures						
Parameter		Top and Leveling Course		Base Course		
Number	Description	Range 1 (a)	Range 2	Range 1 (a)	Range 2	
1	AC Content	-0.30 to +0.40	±0.50	-0.30 to +0.40	±0.50	
2	% Passing	#8 & Larger	±5.0	±8.0	±7.0	±9.0
		#30	±4.0	±6.0	±6.0	±9.0
		#200	±1.0	±2.0	±2.0	±3.0
a. This range allows for normal mixture and testing variations. The mixture must be proportioned to test as closely as possible to the JMF.						

The mixture will be considered out of specification, as determined by the acceptance tests, if for any one mixture, two consecutive tests per parameter (for Parameter 2, two consecutive aggregate gradations on one sieve) are outside Range 1 or Range 2 tolerance limits. Consecutive refers to the production order and not necessarily the testing order. Out-of-specification mixtures are subject to a price adjustment per Table 801-8.

Contractor operations will be suspended and the contractor shall take corrective action when the mixture is determined to be out-of-specification, but contract time will continue to run. The contractor shall submit a revised JMF or proposed alterations to the plan and/or materials to achieve the approved JMF to the Engineer in writing. Productions and placement cannot resume until the receipt of the Engineer's approval to proceed.

**(2) Mat density.** Acceptance of in-place HMA shall be determined on a subplot basis and will be determined by density measurements. The density of the in-place HMA will be determined with the use of a nuclear gauge, using the  $G_{mm}$  from the JMF for the density control target. The required in-place density of the HMA mixture must be 92.0% to 98.0% of the density control target.

In the event that a density test for a subplot does not meet the density requirement, at the Engineer's discretion, one additional test can be taken from the subplot. The average of the two tests will then become the density value for that subplot.

There shall be no price reduction penalty based in-place HMA density. All sublots not meeting the density requirements shall be removed and replaced at no cost to the project.

**(3) Smoothness.** Smoothness of the surface will be accepted on a lot basis. Lot size shall be 801-5.1 a. (1). The final surface shall be free from roller marks. After the final rolling, but not later than 24 hours after placement, the surface of each lot shall be tested in both longitudinal and transverse directions for smoothness to reveal all surface irregularities exceeding the tolerances specified. The finished surface course of the pavement shall not vary more than 1/4 inch (6mm) when evaluated with a 12-foot (3.7m) straightedge. When the surface course smoothness exceeds specification tolerances which cannot be corrected by diamond grinding of the surface course, full depth removal and replacement of surface course shall be required.

(a) Transverse measurements. Transverse measurements will be taken for each lot placed. Transverse measurements will be taken perpendicular to the pavement centerline each 50 feet or more often as determined by the Engineer.

(b) Longitudinal measurements. Longitudinal measurements will be taken for each lot placed. Longitudinal tests will be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6m); and at the third points of paving lanes when widths of paving lanes are 20 ft (6m) or greater.

(i) Measurements for transverse and longitudinal smoothness shall be continuous across all joints, starting with one-half the length of the straightedge at the edge of pavement section being tested and then moved ahead one-half the length of the straightedge for each successive measurement. Smoothness readings will not be made across grade changes or cross slope transitions; at these transition areas, the straightedge position shall be adjusted to measure surface smoothness and not design grade or cross slope transitions. The amount of surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its

length, and measuring the maximum gap between the straightedge and the pavement surface in the area between these two high points. High spots on final surface course > 1/4 inch (6mm) in transverse direction shall be corrected with diamond grinding or by removing and replacing full depth of surface course. Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The area corrected by grinding should not exceed 10% of the total area of the lot and these areas shall be retested after grinding.

**END OF ITEM X-803**

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## **SECTION 323301 – LANDSCAPING ACCESSORIES**

### **PART 1 - GENERAL**

#### **1.1 SUMMARY**

A. Section Includes:

1. Landscape edging.

#### **1.2 ACTION SUBMITTALS**

A. Product Data: For each type of product.

### **PART 2 - PRODUCTS**

#### **2.1 LANDSCAPING EDGING - STEEL**

A. Material: Weathering steel composition specifically designed to form a natural protective dark brown oxidation film providing protection against ongoing corrosion beyond that of unpainted standard steel.

1. Height: As indicated. Minimum 4"
2. Thickness: As indicated. Minimum 3/16"
3. Stakes: As indicated. Minimum 3/16" x 15" long

B. Manufacturers/Products:

1. Basis of Design: BORCON Concepts Inc. or approved equal.

C. Fabrication:

1. Fabricate in minimum 10-foot lengths to provide required lengths and shapes with true, consistent curves, lines, and angles.
2. Exposed Surfaces: All edges and ends rolled, rounded. Finish cut ends and edges as necessary to provide all surfaces smooth, free of burrs, barbs, splinters, and sharpness.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated.

B. Unless otherwise indicated, install edging after regrading is completed and prior to installation of landscape/filter fabric and mulch material.

- C. Install edging plumb, following adjacent grades and securely anchored at locations indicated on Drawings. Hold top down to avoid contact by mower blades.
- D. Separate metals from dissimilar materials to prevent electrolytic action.

**END OF SECTION 323301**

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**Mead  
& Hunt**