

October 18, 2024

# PROJECT MANUAL

VOLUME 2 OF 3: Divisions 03 - 34

## Valley Central School District 2023 Capital Project - Phase 1

|                                      |                               |
|--------------------------------------|-------------------------------|
| Valley Central High School           | SED No. 44-13-01-06-0-015-033 |
| Valley Central Middle School         | SED No. 44-13-01-06-0-016-023 |
| Berea Elementary School              | SED No. 44-13-01-06-0-017-014 |
| East Coldenham Elementary School     | SED No. 44-13-01-06-0-013-019 |
| Montgomery Elementary School         | SED No. 44-13-01-06-0-004-015 |
| Walden Elementary School             | SED No. 44-13-01-06-0-009-021 |
| Maybrook Alternative Learning Center | SED No. 44-13-01-06-0-002-013 |
| Administration Building              | SED No. 44-13-01-06-1-005-006 |

CSArch Project # 187-2302.01



**EXPIRATION DATE:** 02/28/2025

The design of this project conforms to applicable provisions of the New York State Uniform Fire Prevention and Building Code the New York State Energy Conservation Construction Code and the Manual of Planning Standards of the New York State Education Department

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## SECTION 033000 - CAST-IN-PLACE CONCRETE

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Concrete for composite floor construction.
- B. Slabs on grade.
- C. Concrete Monolith.
- D. Joint devices associated with concrete work.
- E. Concrete curing.

#### 1.2 RELATED REQUIREMENTS

- A. Section 03 10 00 - Concrete Forming and Accessories: Forms and accessories for formwork.
- B. Section 03 20 00 - Concrete Reinforcing.

#### 1.3 REFERENCE STANDARDS

- A. ACI 117 - Specification for Tolerances for Concrete Construction and Materials 2010 (Reapproved 2015).
- B. ACI 211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide 2022.
- C. ACI 211.2 - Standard Practice for Selecting Proportions for Structural Lightweight Concrete 1998 (Reapproved 2004).
- D. ACI 301 - Specifications for Concrete Construction 2020.
- E. ACI 302.1R - Guide to Concrete Floor and Slab Construction 2015.
- F. ACI 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete 2000 (Reapproved 2009).
- G. ACI 305R - Guide to Hot Weather Concreting 2020.
- H. ACI 306R - Guide to Cold Weather Concreting 2016.
- I. ACI 308R - Guide to External Curing of Concrete 2016.

- J. ACI 318 - Building Code Requirements for Structural Concrete and Commentary 2014 (Errata 2018).
- K. ASTM C33/C33M - Standard Specification for Concrete Aggregates 2018.
- L. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens 2021.
- M. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete 2022a.
- N. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50 mm] Cube Specimens) 2021.
- O. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete 2020.
- P. ASTM C150/C150M - Standard Specification for Portland Cement 2022.
- Q. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete 2020.
- R. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method 2016.
- S. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete 2010a (Reapproved 2016).
- T. ASTM C309 - Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete 2019.
- U. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete 2019, with Editorial Revision (2022).
- V. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete 2022.
- W. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete 2020a.
- X. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink) 2020.
- Y. ASTM C1602/C1602M - Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete 2018.
- Z. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types) 2018.



- AA. AA. ASTM E1155 - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers 2020.
- BB. BB. ASTM E1155M - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers (Metric) 2014.
- CC. CC. ASTM E1643 - Standard Practice for Selection, Design, Installation, and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs 2018a.
- DD. DD. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill Under Concrete Slabs 2017.

#### 1.4 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
  - 1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.
- C. Mix Design: Submit proposed concrete mix design.
  - 1. Indicate proposed mix design complies with requirements of ACI 301, Section 4 - Concrete Mixtures.
- D. Material Test Reports: For the following, from a qualified testing agency:
  - 1. Aggregates: Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.
- E. Test Reports: Submit report for each test or series of tests specified.
- F. Construction Joint Layout: Indicate proposed construction joints required to construct the structure.
  - 1. Location of construction joints is subject to approval of the Structural Engineer.
- G. Floor surface flatness and levelness measurements indicating compliance with specified tolerances.
- H. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.
- I. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and a supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM 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. Perform work of this section in accordance with ACI 301 and ACI 318.
- D. Follow recommendations of ACI 305R when concreting during hot weather.
- E. Follow recommendations of ACI 306R when concreting during cold weather.
- F. For slabs required to include moisture vapor reducing admixture (MVRA), do not proceed with placement unless manufacturer's representative is present for every day of placement.

#### 1.6 WARRANTY

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Slabs with Moisture Vapor Reducing Admixture (MVRA): Provide warranty to cover cost of flooring failures due to moisture migration from slabs for ten years.
  - 1. Include cost of repair or removal of failed flooring, placement of topical moisture remediation system, and replacement of flooring with comparable flooring system.
  - 2. Provide warranty by manufacturer of MVRA matching terms of flooring adhesive or primer manufacturer's material defect warranty.

#### 1.7 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
    - a. Contractor's superintendent.
    - b. Independent testing agency responsible for concrete design mixtures.
    - c. Ready-mix concrete manufacturer.
    - d. Concrete Subcontractor.
    - e. Special Inspection and Testing Agency
    - f. Special concrete finish Subcontractor.

- g. Structural Engineer
- 2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, semirigid joint fillers, forms and form removal limitations, vapor-retarder installation, anchor rod and anchorage device installation tolerances, steel reinforcement installation, methods for achieving specified floor and slab flatness and levelness concrete repair procedures, and concrete protection.

## PART 2 PRODUCTS

### 2.1 FORMWORK

- A. Comply with requirements of Section 03 10 00.

### 2.2 REINFORCEMENT MATERIALS

- A. Comply with requirements of Section 03 20 00.

### 2.3 CONCRETE MATERIALS

- A. Cement: ASTM C150/C150M, Type I - Normal Portland type.
  - 1. Acquire cement for entire project from same source.
- B. Fine and Coarse Normal-Weight Aggregates: ASTM C33/C33M.
  - 1. Acquire aggregates for entire project from same source.
  - 2. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
  - 3. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Fly Ash: ASTM C618, Class F.
- D. Water: ASTM C1602/C1602M; clean, potable, and not detrimental to concrete.

### 2.4 ADMIXTURES

- A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
- B. Air Entrainment Admixture: ASTM C260/C260M.
- C. High Range Water Reducing and Retarding Admixture: ASTM C494/C494M Type G.
- D. High Range Water Reducing Admixture: ASTM C494/C494M Type F.
- E. Water Reducing and Accelerating Admixture: ASTM C494/C494M Type E.
- F. Water Reducing and Retarding Admixture: ASTM C494/C494M Type D.

- G. Accelerating Admixture: ASTM C494/C494M Type C.
- H. Retarding Admixture: ASTM C494/C494M Type B.
- I. Water Reducing Admixture: ASTM C494/C494M Type A.
- J. Moisture Vapor Reducing Admixture (MVRA): Liquid, inorganic admixture free of volatile organic compounds (VOCs) and formulated to close capillary systems formed during curing to reduce moisture vapor emission and transmission with no adverse effect on concrete properties or finish flooring.
  - 1. Provide admixture in slabs to receive adhesively applied flooring.

## 2.5 ACCESSORY MATERIALS

- A. Underslab Vapor Retarder: Multi-layer, fabric-, cord-, grid-, or aluminum-reinforced polyethylene or equivalent, complying with, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. The use of single ply polyethylene is prohibited.
  - 1. Installation: Comply with ASTM E1643.
    - a. Single layer, 15 mil minimum.
  - 2. Accessory Products: Vapor retarder manufacturer's recommended tape, adhesive, mastic, prefabricated boots, etc., for sealing seams and penetrations.
- B. Non-Shrink Cementitious Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.
  - 1. Grout: Comply with ASTM C1107/C1107M.
  - 2. Minimum Compressive Strength at 28 Days, ASTM C109/C109M: 7,000 pounds per square inch.
  - 3. Products containing aluminum powder are not permitted.

## 2.6 BONDING AND JOINTING PRODUCTS

- A. Epoxy Bonding System:
  - 1. Complying with ASTM C881/C881M and of Type required for specific application.
- B. Waterstops: Self-expanding rubber strip or butyl strip; swells to 1000 percent of original size in clean water. Size 3/4 by 1 inch, minimum.
- C. Slab Isolation Joint Filler: 1/2 inch thick, height equal to slab thickness, with removable top section that will form 1/2 inch deep sealant pocket after removal.
  - 1. Material: ASTM D1751, cellulose fiber.
- D. Slab Construction Joint Devices: Combination keyed joint form and screed, galvanized steel, with rectangular or round knockout holes for conduit or rebar to pass through joint form at 6 inches on center; ribbed steel stakes for setting.

## 2.7 CURING MATERIALS

- A. Evaporation Reducer: Liquid thin-film-forming compound that reduces rapid moisture loss caused by high temperature, low humidity, and high winds; intended for application immediately after concrete placement.
- B. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. when dry.
- C. Moisture-Retaining Sheet: ASTM C171.
  - 1. Polyethylene film, white opaque, minimum nominal thickness of 4 mil, 0.004 inch.
  - 2. White-burlap-polyethylene sheet, weighing not less than 3.8 ounces per square yard.

## 2.8 CONCRETE MIX DESIGN

- A. Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.
  - 1. For trial mixtures method, employ independent testing agency acceptable to Architect for preparing and reporting proposed mix designs.
- C. Admixtures: Add acceptable admixtures as recommended in ACI 211.1 and at rates recommended or required by manufacturer.
- D. Normal Weight Concrete:
  - 1. Exterior Slab-on-Grade, Foundations Walls, and Piers:
    - a. Minimum Compressive Strength: 4500 psi at 28 days.
    - b. Maximum W/C Ratio: 0.45.
    - c. Total Air Content: 6 percent, plus or minus 1.5 percent. Do not allow air content of trowel-finished floors to exceed 3 percent.
    - d. Slump Limit: 4 inches, 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
  - 2. Interior Slab-on-Grade, Footings, Slab on Deck:
    - a. Minimum Compressive Strength: 4000 psi at 28 days.
    - b. Maximum W/C Ratio: 0.50.
    - c. Air Content: Do not allow air content of trowel-finished floors to exceed 3 percent.
    - d. Slump Limit: 4 inches, 8 inches for concrete with verified slump of 2 to 4 inches before adding high-range water-reducing admixture or plasticizing admixture, plus or minus 1 inch.
  - 3. Fly Ash Content: Maximum 25 percent of cementitious materials by weight.

4. Maximum Aggregate Size: 3/4 inch.

## 2.9 MIXING

- A. Transit Mixers: Comply with ASTM C94/C94M.
- B. Adding Water: If concrete arrives on-site with slump less than suitable for placement, do not add water that exceeds the maximum water-cement ratio or exceeds the maximum permissible slump.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify lines, levels, and dimensions before proceeding with work of this section.

### 3.2 PREPARATION

- A. Formwork: Comply with requirements of ACI 301. Design and fabricate forms to support all applied loads until concrete is cured, and for easy removal without damage to concrete.
- B. Verify that forms are clean and free of rust before applying release agent.
- C. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- D. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in accordance to bonding agent manufacturer's instructions.
  1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.
- E. Where new concrete with integral waterproofing is to be bonded to previously placed concrete, prepare surfaces to be treated in accordance with waterproofing manufacturer's instructions. Saturate cold joint surface with clean water, and remove excess water before application of coat of waterproofing admixture slurry. Apply slurry coat uniformly with semi-stiff bristle brush at rate recommended by waterproofing manufacturer.
- F. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels and pack solid with non-shrink grout.

- G. Interior Slabs on Grade: Install vapor retarder under interior slabs on grade. Comply with ASTM E1643. Lap joints minimum 6 inches. Seal joints, seams and penetrations watertight with manufacturer's recommended products and follow manufacturer's written instructions. Repair damaged vapor retarder before covering.
  - 1. Vapor Retarder Over Granular Fill: Install compactible granular fill before placing vapor retarder as indicated on drawings. Do not use sand.

### 3.3 INSTALLING REINFORCEMENT AND OTHER EMBEDDED ITEMS

- A. Comply with requirements of ACI 301. Clean reinforcement of loose rust and mill scale, and accurately position, support, and secure in place to achieve not less than minimum concrete coverage required for protection.
- B. Install welded wire reinforcement in maximum possible lengths, and offset end laps in both directions. Splice laps with tie wire.
- C. Verify that anchors, seats, plates, reinforcement and other items to be cast into concrete are accurately placed, positioned securely, and will not interfere with concrete placement.

### 3.4 PLACING CONCRETE

- A. Place concrete in accordance with ACI 304R.
- B. Place concrete for floor slabs in accordance with ACI 302.1R.
- C. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- D. Ensure reinforcement, inserts, waterstops, embedded parts, and formed construction joint devices will not be disturbed during concrete placement.
- E. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.
- F. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.

### 3.5 SLAB JOINTING

- A. Locate joints as indicated on drawings.
- B. Anchor joint fillers and devices to prevent movement during concrete placement.

- C. Isolation Joints: Use preformed joint filler with removable top section for joint sealant, total height equal to thickness of slab, set flush with top of slab.
  - 1. Install wherever necessary to separate slab from other building members, including columns, walls, equipment foundations, footings, stairs, manholes, sumps, and drains.
- D. Saw Cut Contraction/Control Joints: Saw cut joints before concrete begins to cool, within 4 to 12 hours after placing; use 3/16 inch thick blade and cut at least 1 inch deep but not less than one quarter (1/4) the depth of the slab.
- E. Construction Joints: Where not otherwise indicated, use metal combination screed and key form, with removable top section for joint sealant.

### 3.6 FLOOR FLATNESS AND LEVELNESS TOLERANCES

- A. An independent testing agency, as specified in Section 01 40 00, will inspect finished slabs for compliance with specified tolerances.
- B. Minimum F(F) Floor Flatness and F(L) Floor Levelness Values:
  - 1. Exposed to View and Foot Traffic: F(F) of 20; F(L) of 15, on-grade only.
  - 2. Under Thick-Bed Tile: F(F) of 20; F(L) of 15, on-grade only.
  - 3. Under Carpeting: F(F) of 25; F(L) of 20, on-grade only.
  - 4. Under Thin Resilient Flooring and Thinset Tile: F(F) of 35; F(L) of 25, on-grade only.
- C. Measure F(F) Floor Flatness and F(L) Floor Levelness in accordance with ASTM E1155 (ASTM E1155M), within 48 hours after slab installation; report both composite overall values and local values for each measured section.
- D. Correct the slab surface if composite overall value is less than specified and if local value is less than two-thirds of specified value or less than F(F) 13/F(L) 10.
- E. Correct defects by grinding or by removal and replacement of the defective
  - 1. work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

### 3.7 CONCRETE FINISHING

- A. Repair surface defects, including tie holes, immediately after removing formwork.
- B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch or more in height.
- C. Concrete Slabs: Finish to requirements of ACI 302.1R, and as follows:



1. Surfaces to Receive Thick Floor Coverings: "Wood float" as described in {rs#1}; thick floor coverings include quarry tile and ceramic tile with full bed setting system.
  2. Surfaces to Receive Thin Floor Coverings: "Steel trowel" as described in {rs#1}; thin floor coverings include carpeting, resilient flooring, seamless flooring, thin set quarry tile, and thin set ceramic tile.
  3. Other Surfaces to Be Left Exposed: Trowel as described in ACI 302.1R, minimizing burnish marks and other appearance defects.
- D. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains as indicated on drawings.

### 3.8 CURING AND PROTECTION

- A. Comply with requirements of ACI 308R. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
1. Normal concrete: Not less than seven days.
  2. High early strength concrete: Not less than four days.
- C. Formed Surfaces: Cure by moist curing with forms in place for full curing period.
- D. Surfaces Not in Contact with Forms:
1. Slabs and Floors To Receive Adhesive-Applied Flooring: Curing compounds and other surface coatings are usually considered unacceptable by flooring and adhesive manufacturers. If such materials must be used, either obtain the approval of the flooring and adhesive manufacturers prior to use or remove the surface coating after curing to flooring manufacturer's satisfaction.
  2. Initial Curing: Start as soon as free water has disappeared and before surface is dry. Keep continuously moist for not less than three days by water ponding, water-saturated sand, water-fog spray, or saturated burlap.
    - a. Saturated Burlap: Saturate burlap-polyethylene and place burlap-side down over floor slab areas, lapping ends and sides; maintain in place.
  3. Final Curing: Begin after initial curing but before surface is dry.
    - a. Moisture-Retaining Sheet: Lap strips not less than 3 inches and seal with waterproof tape or adhesive; secure at edges.

### 3.9 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.

- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
- C. Submit proposed mix design of each class of concrete to inspection and testing firm for review prior to commencement of concrete operations.
- D. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.
- E. Compressive Strength Tests: ASTM C39/C39M, for each test, mold and cure four concrete test cylinders. Obtain test samples for every 100 cubic yards or less of each class of concrete placed.
- F. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
- G. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M.
- H. Slab Testing: Cooperate with manufacturer of specified moisture vapor reducing admixture (MVRA) to allow access for sampling and testing concrete for compliance with warranty requirements.

### 3.10 DEFECTIVE CONCRETE

- A. Test Results: The testing agency shall report test results in writing to Architect and Contractor within 24 hours of test.
- B. Defective Concrete: Concrete not complying with required lines, details, dimensions, tolerances or specified requirements.
- C. Repair or replacement of defective concrete will be determined by the Architect. The cost of additional testing shall be borne by Contractor when defective concrete is identified.
- D. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Architect for each individual area.

### 3.11 PROTECTION

- A. Do not permit traffic over unprotected concrete floor surface until fully cured.

END OF SECTION

## SECTION 034500 - PRECAST ARCHITECTURAL CONCRETE

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Precast architectural concrete units.
  - 2. Reinforcing materials.
  - 3. Concrete materials.
  - 4. Accessories.
  - 5. Grout materials.
- B. Related Requirements:
  - 1. Section 033000 "Cast-in-Place Concrete" site-cast concrete requirements and for installing connection anchors in concrete.
  - 2. Section 051200 "Structural Steel Framing" for furnishing and installing connections attached to structural-steel framing.

#### 1.2 DEFINITIONS

- A. Design Reference Sample: Sample of approved architectural precast concrete color, finish, and texture, preapproved by Architect.

#### 1.3 PREINSTALLATION MEETINGS

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

#### 1.4 ACTION SUBMITTALS

- A. Product Data:
  - 1. Precast architectural concrete unit design mixtures: Include compressive strength and water-absorption tests for each precast concrete mixture.
  - 2. Reinforcing materials.
  - 3. Concrete materials.
  - 4. Accessories.
  - 5. Grout materials.
- B. Shop Drawings:
  - 1. Detail fabrication and installation of architectural precast concrete units.
  - 2. Indicate locations, plans, elevations, dimensions, shapes, and cross sections of each unit.

3. Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.
  4. Indicate details at building corners.
  5. Indicate separate face and backup mixture locations and thicknesses.
  6. Indicate type, size, and length of welded connections by AWS standard symbols. Detail loose and cast-in hardware and connections.
  7. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
  8. Indicate locations, extent, and treatment of dry joints if two-stage casting is proposed.
  9. Include plans and elevations showing unit locations, dimensions, erection sequences, and bracing plans for special conditions.
  10. Indicate location of each architectural precast concrete unit by same identification mark placed on panel.
  11. Indicate relationship of architectural precast concrete units to adjacent materials.
  12. Indicate locations, type, dimensions, and details of facing units, including corner units, special shapes, joint treatment, and anchors.
  13. Indicate multiple wythe connection details.
  14. Coordinate and indicate openings and inserts required by other trades.
  15. If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and indicate modified areas on Shop Drawings. Do not adversely affect the appearance, durability, or strength of units.
- C. Samples: Design reference samples for initial verification of design intent, for each type of finish indicated on exposed surfaces of architectural precast concrete units, in sets of three, representative of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches.
1. When other faces of precast concrete unit are exposed, include Samples illustrating workmanship, color, and texture of backup concrete as well as facing concrete.
    - a. Grout Samples for Initial Selection: Color charts consisting of actual sections of grout showing manufacturer's full range of colors.
- D. Delegated Design Submittals: For architectural precast concrete 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. Show governing panel types, connections, types of reinforcement, including special reinforcement, and concrete cover on reinforcement. Indicate location, type, magnitude, and direction of loads imposed on the building structural frame from architectural precast concrete.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Provide locations, setting diagrams, templates, instructions, and directions, as required, for furnishing and installation of loose connection hardware and anchorage items to be embedded in or attached to other construction.
- B. Material Test Reports: For each of the following items, for tests performed by qualified testing agency.
  - 1. Aggregates.
  - 2. Cementitious materials.
  - 3. Reinforcing materials and prestressing tendons.
  - 4. Admixtures.
- C. Source Quality-Control Reports: For aggregate and cementitious materials.

#### 1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm that assumes responsibility for engineering architectural precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
  - 1. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 116 and PCI MNL 135.
- B. Certified Installer Qualifications: A precast concrete erector qualified and designated by PCI's Certificate of Compliance to erect Category A (Architectural Systems) for nonload-bearing members.
- C. Testing Agency Qualifications: An independent testing agency, acceptable to authorities having jurisdiction, qualified in accordance with ASTM C1077 and ASTM E329 for testing indicated.
- D. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in state where Project is located and who is experienced in providing engineering services of the type indicated.

#### 1.7 MOCKUPS

- A. Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects.
  - 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
  - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver architectural precast concrete units in such quantities and at such times to limit unloading units temporarily on the ground or other rehandling.
- B. Support units during shipment on nonstaining shock-absorbing material.
- C. Store units with adequate dunnage and bracing, and protect units to prevent contact with soil, prevent staining, and prevent cracking, distortion, warping, or other physical damage.
- D. Place stored units so identification marks are clearly visible, and units can be inspected.
- E. Handle and transport units in a manner that avoids excessive stresses that cause cracking or damage.
- F. Lift and support units only at designated points indicated on Shop Drawings.

## PART 2 PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design architectural precast concrete units.
- B. Design Standards: Comply with ACI 318 and design recommendations of PCI MNL 120 applicable to types of architectural precast concrete units indicated.

### 2.2 PRECAST ARCHITECTURAL CONCRETE UNITS

- A. Provide unit types as indicated on Drawings.
- B. Source Limitations: Obtain precast architectural concrete units from single fabricator.

### 2.3 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A615/A615M, Grade 60, deformed.
- B. Supports: Suspend reinforcement from back of mold. Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement in place may only be used if they are not visible in the finished face.

### 2.4 CONCRETE MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I or Type III.

1. For surfaces exposed to view in finished structure, use gray and white cement, of same type, brand, and mill source.
  - a. Standard gray cement is acceptable for use where not exposed to view.
- B. Supplementary Cementitious Materials:
- C. Lightweight Aggregates: Except as modified by PCI MNL 117, ASTM C330/C330M, with absorption of less than 11 percent.
- D. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.
- E. Air-Entraining Admixture: ASTM C260/C260M, certified by manufacturer to be compatible with other required admixtures.
- F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.
  1. Water-Reducing Admixtures: ASTM C494/C494M, Type A.
  2. Retarding Admixture: ASTM C494/C494M, Type B.
  3. Water-Reducing and -Retarding Admixture: ASTM C494/C494M, Type D.
  4. Water-Reducing and -Accelerating Admixture: ASTM C494/C494M, Type E.
  5. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
  6. Plasticizing Admixture: ASTM C1017/C1017M, Type I.
  7. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
  8. Corrosion-Inhibiting Admixture: ASTM C1582/C1582M.

## 2.5 ACCESSORIES

- A. Precast Accessories: Provide clips, hangers, high-density plastic or steel shims, and other accessories required to install architectural precast concrete units.

## 2.6 GROUT MATERIALS

- A. Sand-Cement Grout: Portland cement, ASTM C150/C150M, Type I, and clean, natural sand, ASTM C144 or ASTM C404. Mix at ratio of 1 part cement to 2-1/2 to 3 parts sand, by volume, with minimum water required for placement and hydration. Water-soluble chloride ion content is to be less than 0.06 percent by weight of cement when tested in accordance with ASTM C1218/C1218M.

- B. Nonmetallic, Nonshrink Grout: Packaged, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, Portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C1107/C1107M, Grade A for dry pack and Grades B and C for flowable grout, and of consistency suitable for application within a 30-minute working time. Water-soluble chloride ion content is to be less than 0.06 percent by weight of cement when tested in accordance with ASTM C1218/C1218M.
- C. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C881/C881M, of type, grade, and class to suit requirements.

## 2.7 CONCRETE MIXTURES

- A. Prepare design mixtures for each type of precast concrete required.
  - 1. Use a single design mixture for units with more than one major face or edge exposed.
  - 2. Where only one face of unit is exposed, use either a single design mixture or separate mixtures for face and backup.
- B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at architectural precast concrete fabricator's option.
- C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 or PCI MNL 117 when tested in accordance with ASTM C1218/C1218M.
- D. Normal-Weight Concrete Mixtures: Proportion face and backup mixtures or full-depth mixtures, at fabricator's option by either laboratory trial batch or field test data methods in accordance with ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
  - 1. Compressive Strength (28 Days): 3,500 psi minimum.
  - 2. Maximum Water-Cementitious Materials Ratio: 0.45.
- E. Water Absorption: Six percent by weight or 14 percent by volume, tested in accordance with ASTM C642, except for boiling requirement.
- F. Lightweight Concrete Backup Mixtures: Proportion mixtures by either laboratory trial batch or field test data methods in accordance with ACI 213R, with materials to be used on Project, to provide lightweight concrete with the following properties:
  - 1. Compressive Strength (28 Days): 3,500 psi minimum.
  - 2. Unit Weight: Calculated equilibrium unit weight of 115 lb/cu. ft., plus or minus 3 lb/cu. ft., in accordance with ASTM C567/C567M.
- G. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with PCI MNL 117.



- H. When included in design mixtures, add other admixtures to concrete mixtures in accordance with manufacturer's written instructions.

## 2.8 FABRICATION OF PRECAST ARCHITECTURAL CONCRETE

- A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.
  - 1. Weld-headed studs and deformed bar anchors used for anchorage in accordance with AWS D1.1/D1.1M and AWS C5.4.
- B. Furnish loose hardware items, including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing architectural precast concrete units to supporting and adjacent construction.
- C. Cast-in reglets, slots, holes, and other accessories in architectural precast concrete units, as indicated on the Drawings.
- D. Cast-in openings larger than 10 inches in any dimension. Do not drill or cut openings or prestressing strand without Architect's approval.
- E. Reinforcement: Comply with recommendations in PCI MNL 117 for fabricating, placing, and supporting reinforcement.
  - 1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcing exceeds limits specified in ASTM A775/A775M, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
  - 2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
  - 3. Place reinforcing steel and prestressing strands to maintain at least 3/4-inch minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.
  - 4. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.
- F. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

- G. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
- H. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.
- I. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.
  - 1. Place backup concrete mixture to ensure bond with face-mixture concrete.
- J. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 117.
  - 1. Place self-consolidating concrete without vibration in accordance with PCI TR-6. Ensure adequate bond between face and backup concrete, if used.
- K. Comply with PCI MNL 117 for hot- and cold-weather concrete placement.
- L. Identify pickup points of architectural precast concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each architectural precast concrete unit on a surface that does not show in finished structure.
- M. Cure concrete, in accordance with PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.
- N. Discard and replace architectural precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs comply with requirements in PCI MNL 117 and Architect's approval.

## 2.9 FABRICATION TOLERANCES

- A. Fabricate architectural precast concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

## 2.10 FINISHES

- A. Exposed faces to be free of joint marks, grain, and other obvious defects. Corners, including false joints to be uniform, straight, and sharp. Finish exposed-face surfaces of architectural precast concrete units to match approved sample panels and as follows:

1. PCI's "Architectural Precast Concrete - Color and Texture Selection Guide," of plate numbers indicated.
- B. Finish exposed top surfaces of architectural precast concrete units with smooth, steel-trowel finish.
- C. Finish unexposed surfaces of architectural precast concrete units with as-cast finish.

## 2.11 SOURCE QUALITY CONTROL

- A. Quality-Control Testing: Test and inspect precast concrete in accordance with PCI MNL 117 requirements. If using self-consolidating concrete, also test and inspect in accordance with PCI TR-6, ASTM C1610/C1610M, ASTM C1611/C1611M, ASTM C1621/C1621M, and ASTM C1712.
- B. Owner will employ an independent testing agency to evaluate architectural precast concrete fabricator's quality-control and testing methods.
  1. Allow Owner's testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with Owner's testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.
- C. Strength of precast concrete units is considered deficient if units fail to comply with ACI 318 requirements for concrete strength.
- D. Testing: Fabricator will employ an independent testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength in accordance with ASTM C42/C42M and ACI 318.
  1. A minimum of three representative cores to be taken from units of suspect strength, from locations directed by Architect.
  2. Test cores in an air-dry condition.
  3. Strength of concrete for each series of three cores is considered satisfactory if average compressive strength is equal to at least 85 percent of 28-day design compressive strength and no single core is less than 75 percent of 28-day design compressive strength.
  4. Report test results in writing on same day that tests are performed, with copies to Architect, Contractor, and precast concrete fabricator. Test reports include the following:
    - a. Project identification name and number.
    - b. Date when tests were performed.
    - c. Name of precast concrete fabricator.
    - d. Name of concrete testing agency.

- e. Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.
- E. Patching: If core test results are satisfactory and precast concrete units comply with requirements, clean and dampen core holes and solidly fill with precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.
- F. Defective Units: Discard and replace recast architectural concrete units that do not comply with acceptability requirements in PCI MNL 117, including concrete strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Architect's approval. Architect reserves the right to reject precast units that do not match approved samples, sample panels, and mockups. Replace unacceptable units with precast concrete units that comply with requirements.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, bearing surface tolerances, and other conditions affecting performance of the Work.
- B. Do not install precast concrete units until supporting cast-in-place concrete has attained minimum allowable design compressive strength and supporting steel or other structure is structurally ready to receive loads from precast concrete units.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION OF PRECAST ARCHITECTURAL CONCRETE UNITS

- A. Install clips, hangers, bearing pads, and other accessories required for connecting architectural precast concrete units to supporting members and backup materials.
- B. Erect architectural precast concrete level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.
  - 1. Install temporary steel or plastic spacing shims as precast concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
  - 2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.

3. Remove projecting lifting devices and grout fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
  4. Unless otherwise indicated, maintain uniform joint widths of 3/4 inch.
- C. Connect architectural precast concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.
1. Do not permit connections to disrupt continuity of roof flashing.
- D. Grouting or Dry Packing Connections and Joints: Grout connections where required or indicated. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry pack grout material, tamping until voids are completely filled. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces. Promptly remove grout material from exposed surfaces before it affects finishes or hardens. Keep grouted joints damp for not less than 24 hours after initial set.

### 3.3 ERECTION TOLERANCES

- A. Erect architectural precast concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.

### 3.4 REPAIR

- A. Repair architectural precast concrete units if permitted by Architect. Architect reserves the right to reject repaired units that do not comply with requirements.
- B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 ft.
- C. Prepare and repair damaged galvanized coatings with galvanizing repair paint in accordance with ASTM A780/A780M.
- D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
- E. Remove and replace damaged architectural precast concrete units when repairs do not comply with requirements.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:

1. Erection of loadbearing precast concrete members.
- C. Prepare test and inspection reports.
- D. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.
- E. Additional testing and inspecting, at Contractor's expense, to be performed to determine compliance of replaced or additional work with specified requirements.

### 3.6 CLEANING

- A. Clean surfaces of precast concrete units exposed to view.
- B. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.
- C. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
  1. Perform cleaning procedures, if necessary, in accordance with precast concrete fabricator's recommendations. Protect other work from staining or damage due to cleaning operations.
  2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION

## SECTION 040110.01 - MASONRY CLEANING

### 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 cleaning the following:
  - 1. Brick masonry surfaces that are to be repointed and/or repaired as indicated on the drawings.

#### 1.3 DEFINITIONS

- A. Low-Pressure Spray: 100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s).
- B. Medium-Pressure Spray: 400 to 800 psi (2750 to 5510 kPa); 4 to 6 gpm (0.25 to 0.4 L/s).

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to cleaning masonry including, but not limited to, the following:
    - a. Verify masonry-cleaning equipment and facilities needed to make progress and avoid delays.
    - b. Materials, material application, and sequencing.
    - c. Cleaning program.
    - d. Coordination with building occupants.

#### 1.5 SEQUENCING AND SCHEDULING

- A. Work Sequence: Perform masonry-cleaning work in the following sequence:
  - 1. Remove plant growth.
  - 2. Inspect for open mortar joints. Where repairs are required, delay further cleaning work until after repairs are completed, cured, and dried to prevent the intrusion of water and other cleaning materials into the wall.
  - 3. Remove paint.
  - 4. Clean masonry surfaces.

5. Where water repellents are to be used on or near masonry, delay application of these chemicals until after cleaning.

#### 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  1. Include material descriptions and application instructions.
  2. Include test data substantiating that products comply with requirements.

#### 1.7 INFORMATIONAL SUBMITTALS

- A. Preconstruction Test Reports: For cleaning materials and methods.
- B. Cleaning program.

#### 1.8 QUALITY ASSURANCE

- A. Chemical-Cleaner Manufacturer Qualifications: A firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, and with factory-authorized service representatives who are available for consultation and Project-site inspection, preconstruction product testing, and on-site assistance.
- B. Cleaning Program: Prepare a written cleaning program that describes cleaning process in detail, including materials, methods, and equipment to be used; protection of surrounding materials; and control of runoff during operations. Include provisions for supervising worker performance and preventing damage.
  1. If materials and methods other than those indicated are proposed for any phase of cleaning work, add a written description of such materials and methods, including evidence of successful use on comparable projects and demonstrations to show their effectiveness for this Project.
- C. Mockups: Prepare mockups of cleaning on existing surfaces to demonstrate aesthetic effects and to set quality standards for materials and execution.
  1. Quantity of Mockups: Two total, one per cleaning product.
  2. Cleaning: Clean an area approximately 25 sq. ft. (2.3 sq. m) for each type of cleaner. Clean brick and stone sills
    - a. Test cleaners and methods on samples of adjacent materials for possible adverse reactions. Do not test cleaners and methods known to have deleterious effect.
    - b. Allow a waiting period of not less than seven days after completion of sample cleaning to permit a study of sample panels for negative reactions.
  3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.



## 1.9 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service:
  - 1. Use test areas as indicated and representative of proposed materials and existing construction.
  - 2. Propose changes to materials and methods to suit Project.

## 1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit masonry-cleaning work to be performed according to product manufacturers' written instructions and specified requirements.
- B. Clean masonry surfaces only when air temperature is 40 deg F (4 deg C) and above and is predicted to remain so for at least seven days after completion of cleaning.

## PART 2 PRODUCTS

### 2.1 CLEANING MATERIALS

- A. Water: Potable.
- B. Hot Water: Water heated to a temperature of 140 to 160 deg F (60 to 71 deg C).
- C. Cleaning Products: Both listed to be field tested. Architect to review in the field and approve cleaner.
  - 1. Prosoco; 2010 All Surface Cleaner.
    - a. VOC zero.
  - 2. Prosoco; SafRestorer.
    - a. VOC zero.

### 2.2 ACCESSORY MATERIALS

- A. Liquid Strippable Masking Agent: Manufacturer's standard liquid, film-forming, strippable masking material for protecting glass, metal, glazed masonry, and polished stone surfaces from damaging effects of acidic and alkaline masonry cleaners.

### 2.3 CLEANING SOLUTIONS

- A. Dilute cleaners with water to produce solutions not exceeding concentration recommended in writing by chemical-cleaner manufacturer.

## PART 3 EXECUTION

### 3.1 PROTECTION

- A. Comply with each manufacturer's written instructions for protecting building and other surfaces against damage from exposure to its products. Prevent paint removers and chemical cleaning solutions from coming into contact with people, motor vehicles, landscaping, buildings, and other surfaces that could be harmed by such contact.
  - 1. Cover adjacent surfaces with materials that are proven to resist paint removers and chemical cleaners used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents according to manufacturer's written instructions. Do not apply liquid strippable masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
  - 2. Do not apply chemical solutions during winds of enough force to spread them to unprotected surfaces.
  - 3. Neutralize alkaline and acid wastes before disposal.
  - 4. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

### 3.2 CLEANING MASONRY, GENERAL

- A. Cleaning Appearance Standard: Cleaned surfaces are to have a uniform appearance as viewed from 20 feet (6 m) away by Architect.
- B. Proceed with cleaning in an orderly manner; work from bottom to top of each scaffold width and from one end of each elevation to the other. Ensure that dirty residues and rinse water do not wash over dry, cleaned surfaces.
- C. Use only those cleaning methods indicated for each masonry material and location.
  - 1. Brushes: Do not use wire brushes or brushes that are not resistant to chemical cleaner being used.
  - 2. Spray Equipment: Use spray equipment that provides controlled application at volume and pressure indicated, measured at nozzle. Adjust pressure and volume to ensure that cleaning methods do not damage surfaces, including joints.
    - a. Equip units with pressure gages.
    - b. Apply per manufacturer direction.
- D. Perform each cleaning method indicated in a manner that results in uniform coverage of all surfaces, including corners, moldings, and interstices, and that produces an even effect without streaking or damaging masonry surfaces. Keep wall wet below area being cleaned to prevent streaking from runoff.

- E. Perform additional general cleaning, paint and stain removal, and spot cleaning of small areas that are noticeably different when viewed according to the "Cleaning Appearance Standard" Paragraph, so that cleaned surfaces blend smoothly into surrounding areas.
- F. Water Application Methods:
  - 1. Water-Soak Application: Soak masonry surfaces by applying water continuously and uniformly to limited area for time indicated. Apply water at low pressures and low volumes in multiple fine sprays using perforated hoses or multiple spray nozzles. Erect a protective enclosure constructed of polyethylene sheeting to cover area being sprayed.
  - 2. Water-Spray Applications: Unless otherwise indicated, hold spray nozzle at least 6 inches (150 mm) from masonry surface and apply water in horizontal back-and-forth sweeping motion, overlapping previous strokes to produce uniform coverage.
- G. Cleaner Application Methods: Apply cleaners to masonry surfaces according to chemical-cleaner manufacturer's written instructions; use brush or spray application. Do not allow chemicals to remain on surface for periods longer than those indicated or recommended in writing by manufacturer.
- H. Rinse off chemical residue and soil by working upward from bottom to top of each treated area at each stage or scaffold setting. Periodically during each rinse, test pH of rinse water running off of cleaned area to determine that chemical cleaner is completely removed.
  - 1. Apply neutralizing agent and repeat rinse if necessary to produce tested pH of between 6.7 and 7.5.
- I. After cleaning is complete, remove protection no longer required. Remove tape and adhesive marks.

### 3.3 PRELIMINARY CLEANING

- A. Removing Plant Growth: Completely remove visible plant, moss, and shrub growth from masonry surfaces. Carefully remove plants, creepers, and vegetation by cutting at roots and allowing remaining growth to dry as long as possible before removal. Remove loose soil and plant debris from open joints to whatever depth they occur.
- B. Preliminary Cleaning: Before beginning general cleaning, remove extraneous substances that are resistant to planned cleaning methods. Extraneous substances include paint, calking, asphalt, and tar.
  - 1. Carefully remove heavy accumulations of rigid materials from masonry surface with sharp chisel. Do not scratch or chip masonry surface.

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage chemical-cleaner manufacturer's factory-authorized service representatives for consultation and Project-site inspection, to perform preconstruction product testing, and provide on-site assistance when requested by Architect. Have chemical-cleaner manufacturer's factory-authorized service representatives visit Project site not less than once to observing progress and quality of the work.

### 3.5 FINAL CLEANING

- A. Clean adjacent non-masonry surfaces of spillage and debris. Use detergent and soft brushes or cloths.
- B. Remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.
- C. Remove masking materials, leaving no residues that could trap dirt.

END OF SECTION

## SECTION 040120.63 - BRICK MASONRY REPAIR

### TIPS:

TO VIEW NON-PRINTING EDITOR'S NOTES THAT PROVIDE GUIDANCE FOR EDITING, CLICK ON MASTERWORKS/SINGLE-FILE FORMATTING/TOGGLE/EDITOR'S NOTES.

TO READ DETAILED RESEARCH, TECHNICAL INFORMATION ABOUT PRODUCTS AND MATERIALS, AND COORDINATION CHECKLISTS, CLICK ON MASTERWORKS/SUPPORTING INFORMATION.

### PART 1 GENERAL

#### 4.1 RELATED DOCUMENTS

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

#### 4.2 SUMMARY

- A. Section Includes:
  - 1. Repairing brick masonry, including replacing brick.units.
  - 2. Removing abandoned anchors.
  - 3. Brick restoration anchors for existing brick.
  - 4. Painting steel uncovered during the work.
  - 5. Flashing replacement.
  - 6. Brick ties.

#### 4.3 ALLOWANCES

- A. Allowances for brick masonry repair are specified in Section 012100 "Allowances."
- B. Preconstruction testing is part of testing and inspecting allowance.
- C. Abandoned anchor removal is part of .
- D. Brick removal and replacement is part of brick removal and replacement allowance.
- E. Patching masonry units is part of brick masonry patching allowance.

#### 4.4 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."

1. Unit prices apply to authorized work covered by [quantity allowances] [estimated quantities].
2. Unit prices apply to additions to and deletions from Work as authorized by Change Orders.

#### 4.5 DEFINITIONS

- A. Low-Pressure Spray: [100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)] .
- B. Rebuilding (Setting) Mortar: Mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.
- C. Saturation Coefficient: Ratio of the weight of water absorbed during immersion in cold water to weight absorbed during immersion in boiling water; used as an indication of resistance of masonry units to freezing and thawing.

#### 4.6 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] .
  1. Review methods and procedures related to brick masonry repair including, but not limited to, the following:
    - a. Verify brick masonry repair specialist's personnel, equipment, and facilities needed to make progress and avoid delays.
    - b. Materials, material application, sequencing, tolerances, and required clearances.
    - c. Quality-control program.
    - d. Coordination with building occupants.
    - e. .

#### 4.7 SEQUENCING AND SCHEDULING

- A. Order sand[ and gray portland cement] for colored mortar immediately after approval of [Samples] [mockups]. Take delivery of and store at Project site enough quantity to complete Project.
- B. Work Sequence: Perform brick masonry repair work in the following sequence, which includes work specified in this and other Sections:
  1. Remove plant growth.
  2. Inspect masonry for open mortar joints and point them before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
  3. Remove paint.
  4. Clean masonry.
  5. Rake out mortar from joints surrounding masonry to be replaced and from joints adjacent to masonry repairs along joints.

6. Repair masonry, including replacing existing masonry with new masonry materials.
  7. Rake out mortar from joints to be repointed.
  8. Point mortar and sealant joints.
  9. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.
  10. Where water repellents are to be used on or near masonry work, delay application of these chemicals until after pointing and cleaning.
- C. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in masonry units according to "Masonry Unit Patching" Article. Patch holes in mortar joints according to Section 040120.64 "Brick Masonry Repointing."

#### 4.8 ACTION SUBMITTALS

- A. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  2. Include recommendations for product application and use. Include test data substantiating that products comply with requirements.
- B. Shop Drawings:
1. Include plans, elevations, sections, and locations of replacement masonry units on the structure, showing relation of existing and new or relocated units.
  2. Show provisions for expansion joints or other sealant joints.
  3. Show provisions for flashing, lighting fixtures, conduits, and weep holes as required.
  4. Show locations of scaffolding and points of scaffolding in contact with masonry. Include details of each point of contact or anchorage.
- C. Samples for Initial Selection: For the following:
1. Colored Mortar: Submit sets of mortar that will be left exposed in the form of sample mortar strips, 6 inches (150 mm) long by [1/4 inch (6 mm)] [1/2 inch (13 mm)] wide, set in aluminum or plastic channels.
    - a. Have each set contain a close color range of at least [three] [six] Samples of different mixes of colored sands and cements that produce a mortar matching existing, cleaned mortar when cured and dry.
    - b. Submit with precise measurements on ingredients, proportions, gradations, and source of colored sands from which each Sample was made.
  2. Sand Types Used for Mortar: Minimum 8 oz. (240 mL) of each in plastic screw-top jars.
  3. Patching Compound: Submit sets of patching compound Samples in the form of plugs (patches in drilled holes) in sample units of masonry representative of the range of masonry colors on the building.

- a. Have each set contain a close color range of at least [three] [six] Samples of different mixes of patching compound that matches the variations in existing masonry when cured and dry.
4. Include similar Samples of accessories involving color selection.
- D. Samples for Verification: For the following:
  1. Each type of brick unit to be used for replacing existing units. Include sets of Samples to show the full range of shape, color, and texture to be expected. For each brick type, provide straps or panels containing at least four bricks. Include multiple straps for brick with a wide range.
  2. Each type of patching compound in the form of briquettes, at least 3 inches (75 mm) long by 1-1/2 inches (38 mm) wide. Document each Sample with manufacturer and stock number or other information necessary to order additional material.
  3. Accessories: Each type of accessory and miscellaneous support.

#### 4.9 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For [brick masonry repair specialist] [including field supervisors and workers] [and] [testing service].
- B. Preconstruction Test Reports: For [existing masonry units and mortar] [and] [replacement masonry units].
- C. Quality-control program.

#### 4.10 QUALITY ASSURANCE

- A. Brick Masonry Repair Specialist Qualifications: Engage an experienced brick masonry repair firm to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing masonry is insufficient experience for masonry repair work.
  1. Field Supervision: Brick masonry repair specialist firm shall maintain experienced full-time supervisors on Project site during times that brick masonry repair work is in progress.
  2. Brick Masonry Repair Worker Qualifications: [When masonry units are being patched, assign at least one worker per crew who is trained and certified by manufacturer of patching compound to apply its products] .
- B. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.



- C. Mockups: Prepare mockups of brick masonry repair to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation.
1. Masonry Repair: Prepare sample areas for each type of masonry repair work performed. If not otherwise indicated, size each mockup not smaller than two adjacent whole units or approximately 48 inches (1200 mm) in least dimension. Construct sample areas in locations in existing walls where directed by Architect unless otherwise indicated. Demonstrate quality of materials, workmanship, and blending with existing work. Include the following as a minimum:
    - a. Replacement: [Four] brick units replaced.
    - b. Patching: Three small holes [at least 1 inch (25 mm) in diameter] [as directed] for each type of brick indicated to be patched.
  2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
  4. Restoration shall be in accordance with National Parks Service US Department of the Interior Preservation Brief 1 Assessing Cleaning and Water Repellent Treatments for Historic Masonry Buildings, and Brief 2 Repointing Mortar Joints in Historic Masonry Buildings.

#### 4.11 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: [Owner will engage] [Engage] a qualified testing agency to perform preconstruction testing on masonry units as follows:
1. Provide test specimens as indicated and representative of proposed materials and existing construction.
  2. Replacement Brick: Test each proposed type of replacement masonry unit according to sampling and testing methods in ASTM C 67 for compressive strength, 24-hour cold-water absorption, five-hour boil absorption, saturation coefficient, and initial rate of absorption (suction).
  3. Existing Brick: Test each type of existing masonry unit indicated for replacement according to testing methods in ASTM C 67 for compressive strength, 24-hour cold-water absorption, five-hour boil absorption, saturation coefficient, and initial rate of absorption (suction). Carefully remove [five] existing units from locations designated by Architect. Take testing samples from these units.
  4. Existing Mortar: Test according to ASTM C 295/C 295M, modified as agreed by testing service and Architect for Project requirements, to determine proportional composition of original ingredients, sizes and colors of aggregates, and approximate strength.
  5. Temporary Patch: As directed by Architect, provide temporary materials followed by permanent repairs at locations from which existing samples were taken.

#### 4.12 DELIVERY, STORAGE, AND HANDLING

- A. Deliver masonry units to Project site strapped together in suitable packs or pallets or in heavy-duty cartons and protected against impact and chipping.
- B. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.
- C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- D. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.
- E. Store sand where grading and other required characteristics can be maintained and contamination avoided.
- F. Handle masonry units to prevent overstressing, chipping, defacement, and other damage.

#### 4.13 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit brick masonry repair work to be performed according to product manufacturers' written instructions and specified requirements.
- B. Temperature Limits, General: Repair masonry units only when air temperature is between 40 and 90 deg F (4 and 32 deg C) and is predicted to remain so for at least seven days after completion of the Work unless otherwise indicated.
- C. Cold-Weather Requirements: Comply with the following procedures for masonry repair unless otherwise indicated:
  - 1. When air temperature is below 40 deg F (4 deg C), heat mortar ingredients, masonry repair materials, and existing masonry walls to produce temperatures between 40 and 120 deg F (4 and 49 deg C).
  - 2. When mean daily air temperature is below 40 deg F (4 deg C), provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for seven days after repair.
- D. Hot-Weather Requirements: Protect masonry repairs when temperature and humidity conditions produce excessive evaporation of water from mortar and repair materials. Provide artificial shade and wind breaks, and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90 deg F (32 deg C) and above unless otherwise indicated.

- E. For manufactured repair materials, perform work within the environmental limits set by each manufacturer.

## PART 2 PRODUCTS

### 5.1 MATERIALS, GENERAL

- A. Source Limitations: Obtain each type of material for repairing brick masonry (brick, cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

### 5.2 MASONRY MATERIALS

- A. Face Brick: As required to complete brick masonry repair work.
  - 1. Brick Matching Existing: Units with colors, color variation within units, surface texture, size, and shape that match existing brickwork. and with physical properties [within 10 percent of those determined from preconstruction testing of selected existing units.] [as listed below:]
    - a. Physical Properties: According to ASTM C 67 and as follows:
      - 1) Compressive Strength: .
      - 2) 24-Hour Cold-Water Submersion Absorption: .
      - 3) Five-Hour Boil Absorption: .
      - 4) Saturation Coefficient: .
      - 5) Initial Rate of Absorption: .
    - b. For existing brickwork that exhibits a range of colors or color variation within units, provide brick that proportionally matches that range and variation rather than brick that matches an individual color within that range.
  - 2. Brick Matching Architect's Sample: Units with colors, color variation within units, surface texture, and physical properties that match Architect's sample. Match existing units in size and shape.
    - a. Physical Properties: According to ASTM C 67 and as follows:
      - 1) Compressive Strength: .
      - 2) 24-Hour Cold-Water Submersion Absorption: .
      - 3) Five-Hour Boil Absorption: .
      - 4) Saturation Coefficient: .
      - 5) Initial Rate of Absorption: .
    - b. For Architect's sample that exhibits a range of colors or color variation within units, provide brick that proportionally matches that range rather than brick that matches an individual color within that range.
  - 3. Special Shapes:

- a. Provide molded, 100 percent solid shapes for applications where core holes or "frogs" could be exposed to view or weather when in final position and where shapes produced by sawing would result in sawed surfaces being exposed to view.
  - b. Provide specially ground units, shaped to match patterns, for arches and where indicated.
  - c. Mechanical chopping or breaking brick, or bonding pieces of brick together by adhesive, are unacceptable procedures for fabricating special shapes.
4. Tolerances as Fabricated: [According to tolerance requirements in ASTM C 216, Type FBX] [According to tolerance requirements in ASTM C 216, Type FBS] .
- B. Building Brick: ASTM C 62, of same vertical dimension as face brick, for masonry work concealed from view.
  1. Grade SW where in contact with earth.
  2. [Grade SW or MW] [Grade SW, MW, or NW] for concealed backup.

### 5.3 MORTAR MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, Type I or Type II, except Type III may be used for cold-weather construction; white[ or gray, or both] where required for color matching of mortar.
  1. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C 114.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Masonry Cement: ASTM C 91/C 91M.
  - 1.
- D. Mortar Cement: ASTM C 1329/C 1329M.
  - 1.
- E. Mortar Sand: ASTM C 144.
  1. Exposed Mortar: Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
  2. Colored Mortar: Natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.
- F. Mortar Pigments: ASTM C 979/C 979M, compounded for use in mortar mixes, and having a record of satisfactory performance in masonry mortars.
  - 1.
- G. Water: Potable.

### 5.4 MANUFACTURED REPAIR MATERIALS

- A. Brick Patching Compound: Factory-mixed cementitious product that is custom manufactured for patching brick masonry.
  - 1.
  - 2. Use formulation that is vapor and water permeable (equal to or more than the masonry unit), exhibits low shrinkage, has lower modulus of elasticity than masonry units being repaired, and develops high bond strength to all types of masonry.
  - 3. Use formulation having working qualities and retardation control to permit forming and sculpturing where necessary.
  - 4. Formulate patching compound in colors and textures to match each masonry unit being patched. Provide [sufficient number of] [no fewer than three] colors to enable matching of the color, texture, and variation of each unit.

#### 5.5 TIES AND ANCHORS

- A. Materials: Provide brick restorations ties and anchors made from materials that comply with subparagraphs below, unless otherwise indicated.
  - 1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82; with ASTM A 153/A 153M, Class B-2 coating.
- B. Corrugated Metal Ties: Not allowed anywhere.
- C. Special masonry anchors not specifically identified shall be provided as part of the work. Such anchors will be submitted to the architect for review prior to their use and shall meet the structural performance required.
- D. Brick Restoration Anchors: one piece stainless steel wall tie; Hohmann & Barnard Spira-Lok restoration anchor, Type 304 stainless, 8 mm diameter, 9.8 inches in length.
- E. Length to be tested in the field and approved by the Architect.
- F. Spacing: 16 inches on center, horiz and vertical.

#### 5.6 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual " and as follows:
  - 1. Copper: ASTM B 370, Temper H00 or H01, cold-rolled copper sheet, 16-oz./sq. ft. (5-kg/sq. m) weight or 0.0216 inch (0.55 mm) thick.
  - 2. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.6 m). Provide splice plates at joints of formed, smooth metal flashing.
  - 3. Provide termination bars if embedment not possible.

## 5.7 ACCESSORY MATERIALS

- A. Setting Buttons and Shims: Resilient plastic, nonstaining to masonry, sized to suit joint thicknesses and bed depths of masonry units, less the required depth of pointing materials unless removed before pointing.
- B. Masking Tape: Nonstaining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.
- C. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer according to [MPI #23 (surface-tolerant, anticorrosive metal primer)] [or] [SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating] .
  - 1. Surface Preparation: Use coating requiring no better than [SSPC-SP 2, "Hand Tool Cleaning"] [SSPC-SP 3, "Power Tool Cleaning"] [or] [SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning"] surface preparation according to manufacturer's literature or certified statement.
  - 2. VOC Limit: Use coating with a VOC content of [400 g/L (3.3 lb/gal.)] or less.
- D. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
  - 1. Previous effectiveness in performing the work involved.
  - 2. Minimal possibility of damaging exposed surfaces.
  - 3. Consistency of each application.
  - 4. Uniformity of the resulting overall appearance.
  - 5. Do not use products or tools that could leave residue on surfaces.

## 5.8 MORTAR MIXES

- A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.
- B. Colored Mortar: Produce mortar of color required by using specified ingredients. Do not alter specified proportions without Architect's approval.
  - 1. Mortar Pigments: Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black which is limited to 2 percent, unless otherwise demonstrated by a satisfactory history of performance.
- C. Do not use admixtures in mortar unless otherwise indicated.
- D. Mixes: Mix mortar materials in the following proportions:
  - 1. Rebuilding (Setting) Mortar by Volume: ASTM C 270, Proportion Specification, [1 part portland cement, 1 part lime, and 6 parts sand] .

2. Rebuilding (Setting) Mortar by Type: ASTM C 270, Proportion Specification, [Type N] unless otherwise indicated; with cementitious material limited to [portland cement and lime] [masonry cement] [or] [mortar cement].
3. Rebuilding (Setting) Mortar by Property: ASTM C 270, Property Specification, [Type N] unless otherwise indicated; with cementitious material limited to [portland cement and lime] [masonry cement] [or] [mortar cement].
4. Pigmented, Colored Mortar: Add mortar pigments to produce exposed, setting (rebuilding) mortar of colors required.

## PART 3 EXECUTION

### 6.1 REPAIR SPECIALIST

- A. Brick Masonry Repair Specialist Firms: Subject to compliance with requirements, [have masonry repair performed by one of the following] [firms that may perform masonry repair include, but are not limited to, the following]:
  1. .

### 6.2 PROTECTION

- A. Prevent mortar from staining face of surrounding masonry and other surfaces.
  1. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
  2. Keep wall area wet below rebuilding and repair work to discourage mortar from adhering.
  3. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.
- B. Remove[ gutters and] downspouts and associated hardware adjacent to masonry and store during masonry repair. Reinstall when repairs are complete.
  1. Provide temporary rain drainage during work to direct water away from building.

### 6.3 MASONRY REPAIR, GENERAL

- A. Appearance Standard: Repaired surfaces are to have a uniform appearance as viewed from [20 feet (6 m)] [50 feet (15 m)] away by Architect.

### 6.4 ABANDONED ANCHOR REMOVAL

- A. Remove abandoned anchors, brackets, wood nailers, and other extraneous items [no longer in use unless indicated to remain] [indicated to be removed].
  1. Remove items carefully to avoid spalling or cracking masonry.
  2. Notify Architect before proceeding if an item cannot be removed without damaging surrounding masonry. Do the following where directed:

- a. Cut or grind off item approximately [3/4 inch (20 mm)] beneath surface and core drill a recess of same depth in surrounding masonry as close around item as practical.
  - b. Immediately paint exposed end of item with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended dry film thickness per coat. Keep paint off sides of recess.
3. Patch hole where each item was removed unless directed to remove and replace masonry unit.

## 6.5 BRICK REMOVAL AND REPLACEMENT AND RESTORATION

- A. At locations indicated, remove bricks that are damaged, spalled, or deteriorated[ or are to be reused]. Carefully remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full-size units.
  1. When removing single bricks, remove material from center of brick and work toward outside edges.
- B. Support and protect remaining masonry that surrounds removal area.
- C. Maintain flashing, reinforcement, lintels, and adjoining construction in an undamaged condition.[ Coordinate with new flashing, reinforcement, and lintels, which are specified in other Sections.]
- D. Notify Architect of unforeseen detrimental conditions including voids, cracks, bulges, and loose units in existing masonry backup, rotted wood, rusted metal, and other deteriorated items.
- E. Remove in an undamaged condition as many whole bricks as possible.
  1. Remove mortar, loose particles, and soil from brick by cleaning with hand chisels, brushes, and water.
  2. Remove sealants by cutting close to brick with utility knife and cleaning with solvents.
  3. Store brick for reuse. Store off ground, on skids, and protected from weather.
  4. Deliver cleaned brick not required for reuse to Owner unless otherwise indicated.
- F. Clean masonry surrounding removal areas by removing mortar, dust, and loose particles in preparation for brick replacement.
- G. Replace removed damaged brick with other removed brick in good condition, where possible, [or with new brick ]matching existing brick. Do not use broken units unless they can be cut to usable size.
- H. Install replacement brick into bonding and coursing pattern of existing brick. If cutting is required, use a motor-driven saw designed to cut masonry with clean, sharp, unchipped edges.



1. Maintain joint width for replacement units to match existing joints.
  2. Use setting buttons or shims to set units accurately spaced with uniform joints.
- I. Lay replacement brick with rebuilding (setting) mortar and with completely filled bed, head, and collar joints. Butter ends with enough mortar to fill head joints and shove into place. Wet both replacement and surrounding bricks that have ASTM C 67 initial rates of absorption (suction) of more than 30 g/30 sq. in. per min. (30 g/194 sq. cm per min.) Use wetting methods that ensure that units are nearly saturated but surface is dry when laid.
1. Tool exposed mortar joints in repaired areas to match joints of surrounding existing brickwork.
  2. Rake out mortar used for laying brick before mortar sets according to Section 040120.64 "Brick Masonry Repointing." Point at same time as repointing of surrounding area.
  3. When mortar is hard enough to support units, remove shims and other devices interfering with pointing of joints.
- J. Curing: Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.
1. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.
  2. Brick Restoration Anchors:
  3. Install in locations indicated, per anchor manufacturer recommendations.
  4. Drill pilot holes for installation.
  5. Fill holes in brick with sealant. Color match sealant to brick color.

## 6.6 PAINTING STEEL UNCOVERED DURING THE WORK

- A. Notify Architect if steel is exposed during masonry removal. Where Architect determines that steel is structural, or for other reasons cannot be totally removed, prepare and paint it as follows:
1. Surface Preparation: Remove paint, rust, and other contaminants according to [SSPC-SP 2, "Hand Tool Cleaning"] [SSPC-SP 3, "Power Tool Cleaning"] [or] [SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning"] , as applicable to comply with paint manufacturer's recommended preparation.
  2. Antirust Coating: Immediately paint exposed steel with two coats of antirust coating, following coating manufacturer's written instructions and without exceeding manufacturer's recommended rate of application (dry film thickness per coat).
- B. If on inspection and rust removal, the thickness of a steel member is found to be reduced from rust by more than [1/16 inch (1.6 mm)] , notify Architect before proceeding.

## 6.7 MASONRY UNIT PATCHING

- A. Patch the following masonry units unless another type of repair or replacement is indicated:
  - 1. Units indicated to be patched.
  - 2. Units with holes.
  - 3. Units with chipped edges or corners.[ Patch chipped edges or corners measuring more than 3/4 inch (19 mm) in least dimension.]
  - 4. Units with small areas of deep deterioration.[ Patch deep deteriorations measuring more than 3/4 inch (19 mm) in least dimension and more than 1/4 inch (6 mm) deep.]
- B. Remove and replace existing patches [where indicated] [unless otherwise indicated or approved by Architect].
- C. Patching Bricks:
  - 1. Remove loose material from masonry surface. Carefully remove additional material so patch does not have feathered edges but has square or slightly undercut edges on area to be patched and is at least [1/4 inch (6 mm)] thick, but not less than recommended in writing by patching compound manufacturer.
  - 2. Mask adjacent mortar joint or rake out for repointing if patch extends to edge of masonry unit.
  - 3. Mix patching compound in individual batches to match each unit being patched. Combine one or more colors of patching compound, as needed, to produce exact match.
  - 4. Rinse surface to be patched and leave damp, but without standing water.
  - 5. Brush-coat surfaces with slurry coat of patching compound according to manufacturer's written instructions.
  - 6. Place patching compound in layers as recommended in writing by patching compound manufacturer, but not less than 1/4 inch (6 mm) or more than 2 inches (50 mm) thick. Roughen surface of each layer to provide a key for next layer.
  - 7. Trowel, scrape, or carve surface of patch to match texture and surrounding surface plane or contour of masonry unit. Shape and finish surface before or after curing, as determined by testing, to best match existing masonry unit.
  - 8. Keep each layer damp for 72 hours or until patching compound has set.
  - 9. Remove and replace patches with hairline cracks or that show separation from brick at edges, and those that do not match adjoining brick in color or texture.

## 6.8 FINAL CLEANING

- A. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water applied by low-pressure spray.
  - 1. Do not use metal scrapers or brushes.
  - 2. Do not use acidic or alkaline cleaners.

- B. Clean adjacent non-masonry surfaces. Use detergent and soft brushes or cloths.
- C. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.
- D. Remove masking materials, leaving no residues that could trap dirt.

#### 6.9 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.
- B. Architect's Project Representatives: Architect will assign Project representatives to help carry out Architect's responsibilities at the site, including observing progress and quality of portion of the Work completed. Allow Architect's Project representatives use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed.
- C. Notify [inspectors] [and] [Architect's Project representatives] in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until [inspectors] [and] [Architect's Project representatives] have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

#### 6.10 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property.
- B. Masonry Waste: Remove masonry waste and legally dispose of off Owner's property.

END OF SECTION

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## SECTION 040120.64 - BRICK MASONRY REPOINTING

### 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. Repointing joints with mortar.
  - 2. Repointing joints with sealant.

#### 1.3 ALLOWANCES

- A. Allowances for repointing brick masonry are specified in Section 012100 "Allowances."
- B. Preconstruction testing is part of testing and inspecting allowance.
- C. Repointing masonry is part of brick masonry repointing allowance.

#### 1.4 UNIT PRICES

- A. Work of this Section is affected by unit prices specified in Section 012200 "Unit Prices."
  - 1. Unit prices apply to authorized work covered by [quantity allowances] [estimated quantities].
  - 2. Unit prices apply to additions to and deletions from Work as authorized by Change Orders.

#### 1.5 DEFINITIONS

- A. Low-Pressure Spray: [100 to 400 psi (690 to 2750 kPa); 4 to 6 gpm (0.25 to 0.4 L/s)] .

#### 1.6 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] .
  - 1. Review methods and procedures related to repointing brick masonry including, but not limited to, the following:
    - a. Verify brick masonry repointing specialist's personnel, equipment, and facilities needed to make progress and avoid delays.

- b. Materials, material application, sequencing, tolerances, and required clearances.
- c. Quality-control program.
- d. Coordination with building occupants.
- e. .

## 1.7 SEQUENCING AND SCHEDULING

- A. Order sand[ and gray portland cement] for pointing mortar immediately after approval of [Samples] [mockups]. Take delivery of and store at Project site enough quantity to complete Project.
- B. Work Sequence: Perform brick masonry repointing work in the following sequence, which includes work specified in this and other Sections:
  - 1. Remove plant growth.
  - 2. Inspect masonry for open mortar joints and permanently or temporarily point them before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
  - 3. Remove paint.
  - 4. Clean masonry.
  - 5. Rake out mortar from joints surrounding masonry to be replaced and from joints adjacent to masonry repairs along joints.
  - 6. Repair masonry, including replacing existing masonry with new masonry materials.
  - 7. Rake out mortar from joints to be repointed.
  - 8. Point mortar and sealant joints.
  - 9. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.
  - 10. Where water repellents are to be used on or near masonry work, delay application of these chemicals until after pointing and cleaning.
- C. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in masonry units according to Section 040120.63 "Brick Masonry Repair." Patch holes in mortar joints according to "Repointing Masonry" Article.

## 1.8 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include recommendations for product application and use. Include test data substantiating that products comply with requirements.
- B. Shop Drawings:

1. Include plans, elevations, sections, and locations of repointing work on the structure.
  2. Show provisions for expansion joints or other sealant joints.
  3. Show locations of scaffolding and points of scaffolding in contact with masonry. Include details of each point of contact or anchorage.
- C. Samples for Initial Selection: For the following:
1. Pointing Mortar: Submit sets of mortar for pointing in the form of sample mortar strips, 6 inches (150 mm) long by [1/4 inch (6 mm)] [1/2 inch (13 mm)] wide, set in aluminum or plastic channels.
    - a. Have each set contain a close color range of at least [three] [six] Samples of different mixes of colored sands and cements that produce a mortar matching existing, cleaned mortar when cured and dry.
    - b. Submit with precise measurements on ingredients, proportions, gradations, and source of colored sands from which each Sample was made.
  2. Sand Type Used for Pointing Mortar: Minimum 8 oz. (240 mL) of each in plastic screw-top jars.
  3. Sealant materials.
  4. Include similar Samples of accessories involving color selection.
- D. Samples for Verification: For the following:
1. Each type, color, and texture of pointing mortar in the form of sample mortar strips, 6 inches (150 mm) long by [1/4 inch (6 mm)] [1/2 inch (13 mm)] wide, set in aluminum or plastic channels.
    - a. Include with each Sample a list of ingredients with proportions of each. Identify sources, both supplier and quarry, of each type of sand and brand names of cementitious materials and pigments if any.
  2. Sealant materials.
  3. Accessories: Each type of accessory and miscellaneous support.
- 1.9 INFORMATIONAL SUBMITTALS
- A. Qualification Data: For [brick masonry repointing specialist] [including field supervisors and workers] [and] [testing service].
  - B. Preconstruction Test Reports: For existing masonry units and mortar.
  - C. Quality-control program.
- 1.10 QUALITY ASSURANCE

- A. Brick Masonry Repointing Specialist Qualifications: Engage an experienced brick masonry repointing firm to perform work of this Section. Firm shall have completed work similar in material, design, and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing masonry is insufficient experience for masonry repointing work.
  - 1. Field Supervision: Brick masonry repointing specialist firms shall maintain experienced full-time supervisors on Project site during times that brick masonry repointing work is in progress.
- B. Quality-Control Program: Prepare a written quality-control program for this Project to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.
- C. Mockups: Prepare mockups of brick masonry repointing to demonstrate aesthetic effects and to set quality standards for materials and execution.
  - 1. Repointing: Rake out joints in two separate areas[, each approximately 2436 inches (900 mm) high by 2448 inches (1200 mm) wide] [as indicated] for each type of repointing required, and repoint one of the areas.
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
  - 4. Restoration shall be in accordance with National Parks Service US Department of the Interior Preservation Brief 1 Assessing Cleaning and Water Repellent Treatments for Historic Masonry Buildings, and Brief 2 Repointing Mortar Joints in Historic Masonry Buildings.

#### 1.11 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: [Owner will engage] [Engage] a qualified testing agency to perform preconstruction testing on masonry units as follows:
  - 1. Provide test specimens as indicated and representative of proposed materials and existing construction.
  - 2. Existing Brick: Test each type of existing brick indicated for repointing according to testing methods in ASTM C 67 for compressive strength, 24-hour cold-water absorption, five-hour boil absorption, saturation coefficient, and initial rate of absorption (suction). Carefully remove [five] existing units from locations designated by Architect. Take testing samples from these units.
  - 3. Existing Mortar: Test according to ASTM C 295/C 295M, modified as agreed by testing service and Architect for Project requirements, to determine proportional composition of original ingredients, sizes and colors of aggregates, and approximate strength.



4. Temporary Patch: As directed by Architect, provide temporary materials followed by permanent repairs at locations from which existing samples were taken.

#### 1.12 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged materials to Project site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two days.
- D. Store sand where grading and other required characteristics can be maintained and contamination avoided.

#### 1.13 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit repointing work to be performed according to product manufacturers' written instructions and specified requirements.
- B. Temperature Limits, General: Repoint mortar joints only when air temperature is between 40 and 90 deg F (4 and 32 deg C) and is predicted to remain so for at least seven days after completion of the Work unless otherwise indicated.
- C. Cold-Weather Requirements: Comply with the following procedures for mortar-joint pointing unless otherwise indicated:
  1. When air temperature is below 40 deg F (4 deg C), heat mortar ingredients and existing masonry walls to produce temperatures between 40 and 120 deg F (4 and 49 deg C).
  2. When mean daily air temperature is below 40 deg F (4 deg C), provide enclosure and heat to maintain temperatures above 32 deg F (0 deg C) within the enclosure for seven days after pointing.
- D. Hot-Weather Requirements: Protect mortar-joint pointing when temperature and humidity conditions produce excessive evaporation of water from mortar materials. Provide artificial shade and wind breaks, and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90 deg F (32 deg C) and above unless otherwise indicated.

### PART 2 PRODUCTS

#### 2.1 MATERIALS, GENERAL

- A. Source Limitations: Obtain each type of material for repointing brick masonry (cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

## 2.2 MORTAR MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, Type I or Type II, except Type III may be used for cold-weather construction; white[ or gray, or both] where required for color matching of mortar.
  - 1. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C 114.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Masonry Cement: ASTM C 91/C 91M.
  - 1.
- D. Mortar Cement: ASTM C 1329/C 1329M.
  - 1.
- E. Mortar Sand: ASTM C 144.
  - 1. Match size, texture, and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
  - 2. Color: Natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.
- F. Mortar Pigments: ASTM C 979/C 979M, compounded for use in mortar mixes, and having a record of satisfactory performance in masonry mortars.
  - 1.
- G. Water: Potable.

## 2.3 ACCESSORY MATERIALS

- A. Sealant Materials:
  - 1. Sealant manufacturer's standard elastomeric sealant(s) of base polymer and characteristics indicated below and according to applicable requirements in Section 079200 "Joint Sealants."
    - a. Type: [Single-component, nonsag urethane sealant] .
  - 2. Colors: Provide colors of exposed sealants to match colors of mortar adjoining installed sealant unless otherwise indicated.
  - 3. Ground-Mortar Aggregate: Custom crushed and ground pointing mortar sand or existing mortar retrieved from joints. Grind to a particle size that matches the adjacent mortar aggregate and color. Remove all fines passing the [No. 100] sieve.

- B. Joint-Sealant Backing:
  - 1. Cylindrical Sealant Backings: ASTM C 1330, [Type C (closed-cell material with a surface skin)] [or] [Type B (bicellular material with a surface skin)], and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
  - 2. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended in writing by sealant manufacturer for preventing sealant from adhering to rigid, inflexible, joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.
- C. Masking Tape: Nonstaining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.
- D. Other Products: Select materials and methods of use based on the following, subject to approval of a mockup:
  - 1. Previous effectiveness in performing the work involved.
  - 2. Minimal possibility of damaging exposed surfaces.
  - 3. Consistency of each application.
  - 4. Uniformity of the resulting overall appearance.
  - 5. Do not use products or tools that could leave residue on surfaces.

## 2.4 MORTAR MIXES

- A. Measurement and Mixing: Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.
  - 1. Mixing Pointing Mortar: Thoroughly mix cementitious materials and sand together before adding any water. Then mix again, adding only enough water to produce a damp, unworkable mix that retains its form when pressed into a ball. Maintain mortar in this dampened condition for 15 to 30 minutes. Add remaining water in small portions until mortar reaches desired consistency. Use mortar within one hour of final mixing; do not retemper or use partially hardened material.
- B. Colored Mortar: Produce mortar of color required by using specified ingredients. Do not alter specified proportions without Architect's approval.
  - 1. Mortar Pigments: Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black which is limited to 2 percent, unless otherwise demonstrated by a satisfactory history of performance.
- C. Do not use admixtures in mortar unless otherwise indicated.

- D. Mixes: Mix mortar materials in the following proportions:
1. Pointing Mortar by Volume: ASTM C 270, Proportion Specification, [1 part portland cement, 1 part lime, and 6 parts sand] .[ Add mortar pigments to produce mortar colors required.]
  2. Pointing Mortar by Type: ASTM C 270, Proportion Specification, [Type N] unless otherwise indicated; with cementitious material limited to [portland cement and lime] [masonry cement] [or] [mortar cement].[ Add mortar pigments to produce mortar colors required.]
  3. Pointing Mortar by Property: ASTM C 270, Property Specification, [Type N] unless otherwise indicated; with cementitious material limited to [portland cement and lime] [masonry cement] [or] [mortar cement].[ Add mortar pigments to produce mortar colors required.]

### PART 3 EXECUTION

#### 3.1 REPOINTING SPECIALIST

- A. Brick Masonry Repointing Specialist Firms: Subject to compliance with requirements, [have masonry repointing performed by one of the following] [firms that may perform masonry repointing include, but are not limited to, the following]:
1. .

#### 3.2 PROTECTION

- A. Prevent mortar from staining face of surrounding masonry and other surfaces.
1. Cover sills, ledges, and other projecting items to protect them from mortar droppings.
  2. Keep wall area wet below pointing work to discourage mortar from adhering.
  3. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.
- B. Remove[ gutters and] downspouts and associated hardware adjacent to masonry and store during masonry repointing. Reinstall when repointing is complete.
1. Provide temporary rain drainage during work to direct water away from building.

#### 3.3 MASONRY REPOINTING, GENERAL

- A. Appearance Standard: Repointed surfaces are to have a uniform appearance as viewed from [20 feet (6 m)] [50 feet (15 m)] away by Architect.

#### 3.4 REPOINTING MASONRY

- A. Rake out and repoint joints to the following extent:
1. All joints in areas indicated.

2. Joints indicated as sealant-filled joints.
3. Joints at locations of the following defects:
  - a. Holes and missing mortar.
  - b. Cracks that can be penetrated 1/4 inch (6 mm) or more by a knife blade 0.027 inch (0.7 mm) thick.
  - c. Cracks [1/16 inch (1.6 mm)] [1/8 inch (3 mm)] or more in width and of any depth.
  - d. Hollow-sounding joints when tapped by metal object.
  - e. Eroded surfaces 1/4 inch (6 mm) or more deep.
  - f. Deterioration to point that mortar can be easily removed by hand, without tools.
  - g. Joints filled with substances other than mortar.
- B. Do not rake out and repoint joints where not required.
- C. Rake out joints as follows, according to procedures demonstrated in approved mockup:
  1. Remove mortar from joints to depth of [joint width plus 1/8 inch (3 mm)] [2 times joint width] [2-1/2 times joint width] , but not less than [1/2 inch (13 mm)] [3/4 inch (20 mm)] or not less than that required to expose sound, unweathered mortar. Do not remove unsound mortar more than [2 inches (50 mm)] deep; consult Architect for direction.
  2. Remove mortar from masonry surfaces within raked-out joints to provide reveals with square backs and to expose masonry for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and loose debris.
  3. Do not spall edges of masonry units or widen joints. Replace or patch damaged masonry units as directed by Architect.
- D. Notify Architect of unforeseen detrimental conditions including voids in mortar joints, cracks, loose masonry units, rotted wood, rusted metal, and other deteriorated items.
- E. Pointing with Mortar:
  1. Rinse joint surfaces with water to remove dust and mortar particles. Time rinsing application so, at time of pointing, joint surfaces are damp but free of standing water. If rinse water dries, dampen joint surfaces before pointing.
  2. Apply pointing mortar first to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than [3/8 inch (9 mm)] until a uniform depth is formed. Fully compact each layer, and allow it to become thumbprint hard before applying next layer.
  3. After deep areas have been filled to same depth as remaining joints, point joints by placing mortar in layers not greater than [3/8 inch (9 mm)] . Fully compact each layer and allow to become thumbprint hard before applying next layer. Where existing masonry units have worn or rounded edges, slightly recess finished mortar surface below face of masonry to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed masonry surfaces or to featheredge the mortar.

4. When mortar is thumbprint hard, tool joints to match original appearance of joints as demonstrated in approved mockup. Remove excess mortar from edge of joint by brushing.
  5. Cure mortar by maintaining in thoroughly damp condition for at least 72 consecutive hours, including weekends and holidays.
  6. Hairline cracking within mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.
- F. Pointing with Sealant: Comply with Section 079200 "Joint Sealants." and as follows:
1. After raking out, keep joints dry and free of mortar and debris.
  2. Clean and prepare joint surfaces.[ Prime joint surfaces unless sealant manufacturer recommends against priming.] Do not allow primer to spill or migrate onto adjoining surfaces.
  3. Fill sealant joints with specified joint sealant.
    - a. Install cylindrical sealant backing beneath the sealant. Where space is insufficient for cylindrical sealant backing, install bond-breaker tape.
    - b. Install sealant using only proven installation techniques that ensure that sealant is deposited in a uniform, continuous ribbon, without gaps or air pockets, and with complete wetting of the joint bond surfaces equally on both sides. Fill joint flush with surrounding masonry and matching the contour of adjoining mortar joints.
    - c. Install sealant as recommended in writing by sealant manufacturer but within the following general limitations, measured at the center (thin) section of the bead:
      - 1) Fill joints to a depth equal to joint width, but not more than 1/2 inch (13 mm) deep or less than 1/4 inch (6 mm) deep.
    - d. Tool sealant to form smooth, uniform beads, slightly concave. Remove excess sealant from surfaces adjacent to joint.
    - e. Sanded Joints: Immediately after first tooling, apply ground-mortar aggregate to sealant, gently pushing aggregate into the surface of sealant. Lightly retool sealant to form smooth, uniform beads, slightly concave. Remove excess sealant and aggregate from surfaces adjacent to joint.
    - f. Do not allow sealant to overflow or spill onto adjoining surfaces, or to migrate into the voids of adjoining surfaces, particularly rough textures. Remove excess and spillage of sealant promptly as the work progresses. Clean adjoining surfaces by the means necessary to eliminate evidence of spillage, without damage to adjoining surfaces or finishes, as demonstrated in an approved mockup.
- G. Where repointing work precedes cleaning of existing masonry, allow mortar to harden at least 30 days before beginning cleaning work.

### 3.5 FINAL CLEANING

- A. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes, and clean water applied by low-pressure spray.
  - 1. Do not use metal scrapers or brushes.
  - 2. Do not use acidic or alkaline cleaners.
- B. Clean adjacent nonmasonry surfaces. Use detergent and soft brushes or cloths.
- C. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.
- D. Remove masking materials, leaving no residues that could trap dirt.

### 3.6 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage qualified testing agency to perform tests and inspections. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.
- B. Architect's Project Representatives: Architect will assign Project representatives to help carry out Architect's responsibilities at the site, including observing progress and quality of portion of the Work completed. Allow Architect's Project representatives use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed.
- C. Notify [inspectors] [and] [Architect's Project representatives] in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until [inspectors] [and] [Architect's Project representatives] have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

END OF SECTION

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## SECTION 042000 - CONCRETE UNIT MASONRY

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Concrete block.
- B. Concrete facing brick.
- C. Decorative concrete masonry units.
- D. Mortar and Grout.
- E. Reinforcement and anchorage.
- F. Flashings.
- G. Lintels.
- H. Accessories.

#### 1.2 RELATED REQUIREMENTS

- A. Section 03 10 00 - Concrete Forming and Accessories: Dovetail slots for masonry anchors.
- B. Section 03 20 00 - Concrete Reinforcing: Reinforcing steel for grouted masonry.
- C. Section 03 30 00 - Cast-in-Place Concrete: Installation of dovetail slots for masonry anchors.

#### 1.3 REFERENCE STANDARDS

- A. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures 2016.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- C. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement 2020.
- D. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units 2022.
- E. ASTM C129 - Standard Specification for Nonloadbearing Concrete Masonry Units 2017.

- F. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar 2018.
- G. ASTM C150/C150M - Standard Specification for Portland Cement 2022.
- H. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes 2018.
- I. ASTM C216 - Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale) 2022.
- J. ASTM C270 - Standard Specification for Mortar for Unit Masonry 2019a, with Editorial Revision.
- K. ASTM C387/C387M - Standard Specification for Packaged, Dry, Combined Materials for Concrete and High Strength Mortar 2017.
- L. ASTM C404 - Standard Specification for Aggregates for Masonry Grout 2018.
- M. ASTM C476 - Standard Specification for Grout for Masonry 2022.
- N. ASTM C979/C979M - Standard Specification for Pigments for Integrally Colored Concrete 2016.
- O. ASTM C1072 - Standard Test Methods for Measurement of Masonry Flexural Bond Strength 2019.
- P. ASTM C1148 - Standard Test Method for Measuring the Drying Shrinkage of Masonry Mortar 1992a (Reapproved 2014).
- Q. ASTM C1314 - Standard Test Method for Compressive Strength of Masonry Prisms 2022.
- R. ASTM C1714/C1714M - Standard Specification for Preblended Dry Mortar Mix for Unit Masonry 2019a.
- S. ASTM D4637/D4637M - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane 2015, with Editorial Revision (2022).
- T. ASTM E514/E514M - Standard Test Method for Water Penetration and Leakage Through Masonry 2020.
- U. BIA Technical Notes No. 7 - Water Penetration Resistance – Design and Detailing 2017.
- V. BIA Technical Notes No. 28B - Brick Veneer/Steel Stud Walls 2005.
- W. BIA Technical Notes No. 46 - Maintenance of Brick Masonry 2017.
- X. TMS 402/602 - Building Code Requirements and Specification for Masonry Structures 2016.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Preinstallation Meeting: Convene a preinstallation meeting one week before starting work of this section; require attendance by all relevant installers.

#### 1.5 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for masonry units, fabricated wire reinforcement, mortar, and masonry accessories.
  - 1. Shop Drawings: Indicate pertinent dimensions, materials, anchorage, size and type of fasteners, and accessories for brickwork support system.
- C. Shop Drawings: For the following:
  - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
  - 2. Reinforcing Steel: Detail bending, lap lengths, and placement of unit masonry reinforcing bars. Comply with ACI 315. Show elevations of reinforced walls.
  - 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
  - 4. Samples: Submit two samples of decorative block and colored mortar to illustrate color, texture, and extremes of color range.
- D. Samples for Initial Selection:
  - 1. Decorative CMUs, in the form of small-scale units.
  - 2. Colored mortar.
- E. Samples for Verification: For each type and color of the following:
  - 1. Exposed Decorative CMUs.
  - 2. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project.
- F. Manufacturer's Certificate: Certify that masonry units meet or exceed specified requirements.
- G. Manufacturer's Certificate: Certify that water repellent admixture manufacturer has certified masonry unit manufacturer as an approved user of water repellent admixture in the manufacture of concrete block.

#### 1.6 QUALITY ASSURANCE

- A. Comply with provisions of TMS 402/602, except where exceeded by requirements of Contract Documents.

- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years of documented experience.

#### 1.7 MOCK-UP

1. Construct a masonry wall as a mock-up panel sized 4 feet long by 4 feet high; include mortar, accessories, structural backup, and flashings (with lap joint, corner, and end dam) in mock-up.
  2. Locate where directed.
  3. Mock-up may remain as part of the Work.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
    1. Build mockups for typical exterior and interior walls in sizes approximately 48 inches long by 36 inches high by full thickness, including face and backup wythes and accessories.
      - a. Include a sealant-filled joint at least 16 inches long in each mockup.
      - b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches wide by 16 inches high.
      - c. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing).
    2. Protect accepted mockups from the elements with weather-resistant membrane.
    3. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
      - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
      - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
    4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, handle, and store masonry units by means that will prevent mechanical damage and contamination by other materials.
- B. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

- C. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

## 1.9 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
  - 1. Extend cover a minimum of 24 inches down both sides of walls, and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

## PART 2 - PRODUCTS

### 2.1 UNIT MASONRY, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed work.
- B. Fire-Resistance Ratings: Comply with requirements for fire-resistance-rated assembly designs indicated.

### 2.2 CONCRETE MASONRY UNITS

- A. Concrete Block - Standard: Comply with referenced standards and as follows:
  - 1. Size: Standard units with nominal face dimensions of 16 by 8 inches and nominal depth of 8 inches.
  - 2. Load-Bearing Units: ASTM C90, normal weight.

- a. Hollow block, as indicated.
  - b. Normalweight
3. Non-Loadbearing Units: ASTM C129.
  - a. Hollow block, as indicated.
  - b. Lightweight.
4. Units with Integral Water Repellent: Concrete block units as specified in this section with polymeric liquid admixture added to concrete masonry units at the time of manufacture.
  - a. Performance of Units with Integral Water Repellent:
    - 1) Water Permeance: When tested per ASTM E514/E514M and for a minimum of 72 hours.
      - a) No water visible on back of wall above flashing at the end of 24 hours.
      - b) No flow of water from flashing equal to or greater than 0.032 gallons per hour at the end of 24 hours.
      - c) No more than 25 percent of wall area above flashing visibly damp at end of test.
    - 2) Flexural Bond Strength: ASTM C1072; minimum 10 percent increase.
    - 3) Compressive Strength: ASTM C1314; maximum 5 percent decrease.
    - 4) Drying Shrinkage: ASTM C1148; maximum 5 percent increase in shrinkage.
  - b. Use only in combination with mortar that also has integral water repellent admixture.
  - c. Use water repellent admixtures for masonry units and mortar by a single manufacturer.
  - d. Exposed Faces: Color and texture to be selected from manufacturer's full range.
  - e. Products:
    - 1) Substitutions: See Section 01 60 00 - Product Requirements.

## 2.3 Decorative cmu (EXTERIOR WALL APPLICATIONS)

1. Basis of Design Product: Subject to compliance with requirements, provide Standard Lightweight CMUs with Ground-Face Finish manufactured by Westbrook Concrete Block Company, Inc. or a comparable product by one of the following:
  - a. Echelon Masonry.
  - b. Jandris Block.
  - c. Nitterhouse Masonry Products, LLC
  - d. RCP Block and Brick, Inc.
2. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi.
3. Density Classification: Lightweight

4. Size (Width): Manufactured to dimensions 3/8 inch less-than-nominal dimensions, as indicated in drawings.
5. Pattern and Texture: Standard pattern, ground-face finish
6. Colors: As selected by Architect from manufacturer's full range.

## 2.4 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C150/C150M, Type I; color as required to produce approved color sample.
  1. Not more than 0.60 percent alkali.
- B. Hydrated Lime: ASTM C207, Type S.
- C. Mortar Aggregate: ASTM C144.
- D. Grout Aggregate: ASTM C404.
- E. Pigments for Colored Mortar: Pure, concentrated mineral pigments specifically intended for mixing into mortar and complying with ASTM C979/C979M.
  1. Color(s): As selected by Architect from manufacturer's full range.
- F. Water: Clean and potable.
- G. Accelerating Admixture: Nonchloride type for use in cold weather.
- H. Integral Water Repellent Admixture for Mortar: Polymeric liquid admixture added to mortar at the time of manufacture.
  1. Use only in combination with masonry units manufactured with integral water repellent admixture.
  2. Use only water repellent admixture for mortar from the same manufacturer as water repellent admixture in masonry units.
  3. Meet or exceed performance specified for water repellent admixture used in masonry units.
- I. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494 / C494M, Type C, and as recommended by manufacturer for use in masonry mortar of composition indicated.
- J. Packaged Dry Material for Mortar for Unit Masonry: Premixed Portland cement, hydrated lime, and sand; complying with ASTM C1714/C1714M and capable of producing mortar of the specified strength in accordance with ASTM C270 with the addition of water only.
  1. Type: Types as scheduled in this section.
  2. Color: Mineral pigments added as required to produce approved color sample.
  3. Water-repellent mortar for use with water repellent masonry units.

- K. Packaged Dry Material for Grout for Masonry: Premixed cementitious materials and dried aggregates; capable of producing grout of the specified strength in accordance with ASTM C476 with the addition of water only.

## 2.5 REINFORCEMENT AND ANCHORAGE

- A. Reinforcing Steel: ASTM A615, Grade 60 (60,000 psi), deformed billet bars; uncoated.
- B. Joint Reinforcement: Use ladder type joint reinforcement where vertical reinforcement is involved and truss type elsewhere, unless otherwise indicated.
- C. Two-Piece Wall Ties: Formed steel wire, 0.1875 inch thick, adjustable, eye and pintle type, hot dip galvanized to ASTM A 153/A 153M, Class B, sized to provide not less than 5/8 inch of mortar coverage from masonry face and to allow vertical adjustment of up to 1-1/4 in.
- D. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A 153/A 153M, Class B.
  - 1. Anchor plates: Not less than 0.075 inch thick, designed for fastening to structural backup through sheathing by two fasteners; provide design with legs that penetrate sheathing and insulation to provide positive anchorage.
  - 2. Wire ties: Manufacturer's standard shape, 0.1875 inch thick.
  - 3. Vertical adjustment: Not less than 3-1/2 inches.
- E. Metal-to-Metal Fasteners: Self-drilling, self-tapping screws; corrosion resistant finish or hot dip galvanized to ASTM A153/A153M.

## 2.6 FLASHINGS

- A. Metal Flashing: Provide metal flashing complying with Section 076200 "Sheet Metal Flashing and Trim".
- B. EPDM Flashing: ASTM D4637/D4637M, Type I, 0.040 inch thick.
  - 1. Manufacturers:
    - a. Hohmann & Barnard, Inc: [www.h-b.com/#sle](http://www.h-b.com/#sle).
- C. Flashing Sealant/Adhesives: Silicone, polyurethane, or silyl-terminated polyether/polyurethane or other type required or recommended by flashing manufacturer; type capable of adhering to type of flashing used.
- D. Application: Unless otherwise indicated, use the following:
  - 1. Where flashing is indicated to receive counterflashing, use metal flashing.
  - 2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.



3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing or flexible flashing with a metal drip edge.
4. Where flashing is fully concealed, use metal flashing or flexible flashing.

## 2.7 ACCESSORIES

- A. Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints.
  1. Manufacturers:
    - a. Blok-Lok Limited: [www.blok-lok.com](http://www.blok-lok.com).
    - b. Hohmann & Barnard, Inc: [www.h-b.com/sle](http://www.h-b.com/sle).
    - c. WIRE-BOND: [www.wirebond.com/#sle](http://www.wirebond.com/#sle).
    - d. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Joint Filler: Closed cell polyvinyl chloride; oversized 50 percent to joint width; self expanding; in maximum lengths available.
  1. Manufacturers:
    - a. Hohmann & Barnard, Inc: [www.h-b.com/sle](http://www.h-b.com/sle).
    - b. WIRE-BOND: [www.wirebond.com/#sle](http://www.wirebond.com/#sle).
    - c. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Cavity Mortar Control: Semi-rigid polyethylene or polyester mesh panels, sized to thickness of wall cavity, and designed to prevent mortar droppings from clogging weeps and cavity vents and allow proper cavity drainage.
- D. Weeps:
  1. Type: Polyester mesh.
  2. Color(s): As selected by Architect from manufacturer's full range.
- E. Cavity Vents:
  1. Type: Polyester mesh.
  2. Color(s): As selected by Architect from manufacturer's full range.
- F. Multicomponent Cavity Wall Drainage System: Combination mortar diverter, flashing and weep system.
  1. Drip Edge: Stainless steel.
  2. Termination Bar: Stainless steel.
  3. Lap Sealants and Tapes: As recommended by flashing manufacturer; compatible with membrane and adhesives.
- G. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

## 2.8 MORTAR AND GROUT MIXING

- A. Mortar for Unit Masonry: ASTM C270, using the Proportion Specification.

1. Masonry below grade and in contact with earth: Type M.
  2. Exterior, loadbearing masonry: Type S.
  3. Exterior, non-loadbearing masonry: Type S.
  4. Interior, loadbearing masonry: Type N.
  5. Interior, non-loadbearing masonry: Type O.
- B. Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment-to-cement ratio.
- C. Grout: ASTM C476; consistency required to fill completely volumes indicated for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches.
- D. Admixtures: Add to mixture at manufacturer's recommended rate and in accordance with manufacturer's instructions; mix uniformly.
- E. Mixing: Use mechanical batch mixer and comply with referenced standards.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that field conditions are acceptable and are ready to receive masonry.
- B. Verify that related items provided under other sections are properly sized and located.
- C. Verify that built-in items are in proper location, and ready for roughing into masonry work.

#### 3.2 PREPARATION

- A. Direct and coordinate placement of metal anchors supplied for installation under other sections.
- B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.

#### 3.3 COLD AND HOT WEATHER REQUIREMENTS

- A. Comply with requirements of TMS 402/602 or applicable building code, whichever is more stringent.

#### 3.4 COURSING

- A. Establish lines, levels, and coursing indicated. Protect from displacement.

- B. Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.
- C. Concrete Masonry Units:
  - 1. Bond: Running.
  - 2. Coursing: One unit and one mortar joint to equal 8 inches.
  - 3. Mortar Joints: Concave.

### 3.5 PLACING AND BONDING

- A. Lay hollow masonry units with face shell bedding on head and bed joints.
- B. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- C. Remove excess mortar and mortar smears as work progresses.
- D. Remove excess mortar with water repellent admixture promptly. Do not use acids, sandblasting or high pressure cleaning methods.
- E. Interlock intersections and external corners.
- F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- G. Perform job site cutting of masonry units with proper tools to provide straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.

### 3.6 WEEPS/CAVITY VENTS

- A. Install weeps in veneer walls at 24 inches on center horizontally above through-wall flashing, above shelf angles and lintels, and at bottom of walls.
- B. Install cavity vents in veneer and cavity walls at 24 inches on center horizontally below shelf angles and lintels and near top of walls.

### 3.7 CAVITY MORTAR CONTROL

- A. Do not permit mortar to drop or accumulate into cavity air space or to plug weep/cavity vents.
- B. Install cavity mortar diverter at base of cavity and at other flashing locations as recommended by manufacturer to prevent mortar droppings from blocking weep/cavity vents.

### 3.8 REINFORCEMENT AND ANCHORAGE - GENERAL, SINGLE WYTHE MASONRY, and CAVITY WALL MASONRY

- A. Unless otherwise indicated on drawings or specified under specific wall type, install horizontal joint reinforcement 16 inches on center.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
- C. Place continuous joint reinforcement in first and second joint below top of walls.
- D. Lap joint reinforcement ends minimum 6 inches.

### 3.9 REINFORCEMENT AND ANCHORAGE - MASONRY VENEER

- A. Masonry Back-Up: Embed anchors to bond veneer at maximum 16 inches on center vertically and 36 inches on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches on center.
- B. Stud Back-Up: Secure veneer anchors to stud framed back-up and embed into masonry veneer at maximum 16 inches on center vertically and 24 inches on center horizontally. Place additional anchors at perimeter of openings and ends of panels, so maximum spacing of anchors is 8 inches on center.

### 3.10 MASONRY FLASHINGS

- A. Whether or not specifically indicated, install masonry flashing to divert water to exterior at all locations where downward flow of water will be interrupted.
  - 1. Extend flashings full width at such interruptions and at least 6 inches, minimum, into adjacent masonry or turn up flashing ends at least 1 inch, minimum, to form watertight pan at non-masonry construction.
  - 2. Remove or cover protrusions or sharp edges that could puncture flashings.
  - 3. Seal lapped ends and penetrations of flashing before covering with mortar.
- B. Extend plastic, laminated, and EPDM flashings to within 1/4 inch of exterior face of masonry.
- C. Lap end joints of flashings at least 6 inches, minimum, and seal watertight with flashing sealant/adhesive.

### 3.11 LINTELS

- A. Install reinforced unit masonry lintels, as scheduled.
  - 1. Do not splice reinforcing bars.
  - 2. Support and secure reinforcing bars from displacement. Maintain position within 1/2 inch of dimensioned position.
  - 3. Place and consolidate grout fill without displacing reinforcing.

4. Allow masonry lintels to attain specified strength before removing temporary supports.

### 3.12 CONTROL AND EXPANSION JOINTS

- A. Do not continue horizontal joint reinforcement through control or expansion joints.
- B. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.
- C. Size control joints as indicated on drawings; if not indicated, 3/4 inch wide and deep.

### 3.13 BUILT-IN WORK

- A. As work progresses, install built-in metal door frames and anchor bolts and other items to be built into the work and furnished under other sections.
- B. Install built-in items plumb, level, and true to line.
- C. Bed anchors of metal door frames in adjacent mortar joints. Fill frame voids solid with grout.
  1. Fill adjacent masonry cores with grout minimum 12 inches from framed openings.
- D. Do not build into masonry construction organic materials that are subject to deterioration.

### 3.14 TOLERANCES

- A. Maximum Variation From Unit to Adjacent Unit: 1/16 inch.
- B. Maximum Variation from Plane of Wall: 1/4 inch in 10 ft and 1/2 inch in 20 ft or more.
- C. Maximum Variation from Plumb: 1/4 inch per story non-cumulative; 1/2 inch in two stories or more.
- D. Maximum Variation from Level Coursing: 1/8 inch in 3 ft and 1/4 inch in 10 ft; 1/2 inch in 30 ft.
- E. Maximum Variation of Mortar Joint Thickness: Head joint, minus 1/4 inch, plus 3/8 inch.

### 3.15 CUTTING AND FITTING

- A. Obtain approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

### 3.16 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.

### 3.17 CLEANING

- A. Remove excess mortar and mortar droppings.
- B. Replace defective mortar. Match adjacent work.
- C. Clean soiled surfaces with cleaning solution.
- D. Use non-metallic tools in cleaning operations.

### 3.18 PROTECTION

- A. Without damaging completed work, provide protective boards at exposed external corners that are subject to damage by construction activities.

END OF SECTION

## SECTION 042613 - MASONRY VENEER

### 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. Clay face brick.
  - 2. Concrete face brick.
  - 3. Mortar.
  - 4. Ties and anchors.
  - 5. Embedded flashing.
  - 6. Miscellaneous masonry accessories.
- B. Products Installed but not Furnished under This Section:
  - 1. Steel lintels in masonry veneer.
  - 2. Steel shelf angles for supporting masonry veneer.
- C. Related Requirements:
  - 1. Section 033000 "Cast-in-Place Concrete" for installing of masonry-veneer anchors.
  - 2. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.

#### 1.3 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).

#### 1.4 PREINSTALLATION MEETINGS

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

#### 1.5 PERFORMANCE REQUIREMENTS

- A. Provide structural masonry that develops indicated net-area compressive strengths (f'm) at 28 days.

- B. Determine net-area compressive strength (f'm) of masonry by testing masonry prisms according to ASTM C 1314.

#### 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For the following:
  - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
  - 2. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- C. Samples for Initial Selection:
  - 1. Clay face brick.
  - 2. Concrete face brick, in the form of small-scale units.
  - 3. Colored mortar.
  - 4. Weep holes/vents.
- D. Samples for Verification: For each type and color of the following:
  - 1. Clay face brick.
  - 2. Special brick shapes.
  - 3. Concrete face brick.
  - 4. Pigmented mortar. Make Samples using same sand and mortar ingredients to be used on Project.
  - 5. Weep holes/vents.
  - 6. Accessories embedded in masonry.

#### 1.7 INFORMATIONAL SUBMITTALS

- A. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
  - 1. Submittal is for information only. Receipt of list does not constitute approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of Architect and approved in writing.
- B. Material Certificates: For each type and size of the following:
  - 1. Masonry units.
    - a. Include material test reports substantiating compliance with requirements.
    - b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
    - c. For exposed brick, include test report for efflorescence according to ASTM C 67.



- d. For surface-coated brick, include test report for durability of surface appearance after 50 cycles of freezing and thawing according to ASTM C 67.
  2. Integral water repellant used in decorative CMUs.
  3. Cementitious materials. Include name of manufacturer, brand name, and type.
  4. Mortar admixtures.
  5. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
  6. Anchors, ties, and metal accessories.
- C. Mix Designs: For each type of mortar. Include description of type and proportions of ingredients.
1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention, and ASTM C 91/C 91M for air content.
- D. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

## 1.8 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
1. Build mockups for each type of exposed masonry construction in sizes approximately 48 inches long by 48 inches high by full thickness, including face and backup wythes and accessories.
    - a. Include a sealant-filled joint at least 16 inches long in each mockup.
    - b. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12 inch length of flashing left exposed to view (omit masonry above half of flashing).
    - c. Include weather-resistive barriers, veneer anchors, flashings, cavity drainage materials, and weep holes in exterior masonry-veneer wall mockup as required for each type of exposed masonry construction.
  2. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
  3. Protect accepted mockups from the elements with weather-resistant membrane.
  4. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
    - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.

- b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
- 5. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained, and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers. Store preblended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

#### 1.10 FIELD CONDITIONS

- A. Protection of Masonry: During construction, cover tops of veneer, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
  - 1. Extend cover a minimum of 24 inches down face of veneer, and hold cover securely in place.
- B. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry. Immediately remove grout, mortar, and soil that come in contact with masonry.
  - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
  - 2. Protect sills, ledges, and projections from mortar droppings.
  - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
  - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

- C. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
  - 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
- D. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

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

### 2.2 UNIT MASONRY, GENERAL

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

### 2.3 BRICK

- A. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:
  - 1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
  - 2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.

3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
  4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
- B. Clay Face Brick: Facing brick complying with ASTM C 216
1. Grade: SW
  2. Type: FBS or HBS
  3. Initial Rate of Absorption: Less than 30 g/30 sq. in. per minute when tested according to ASTM C 67.
  4. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
  5. Surface Coating: Brick with colors or textures produced by application of coatings shall withstand 50 cycles of freezing and thawing according to ASTM C 67 with no observable difference in the applied finish when viewed from 10 feet.
  6. Size (Actual Dimensions): Match Existing. Provide clay face brick matching color range, texture, and size of existing adjacent brickwork.

## 2.4 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.
1. Provide special shapes for lintels, corners, jambs, sashes, movement joints, headers, bonding, and other special conditions.
- B. Integral Water Repellent: Provide units made with integral water repellent for exposed units.
1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E 514/E 514M as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.
- C. Concrete Face Brick: ASTM C1634.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Glen-Gery Brick, or a comparable product by one of the following:
    - a. Bowerston Ohio Quality Brick
    - b. Brampton Brick
    - c. Hebron Brick Company
    - d. Meridian Brick
    - e. Yankee Hill Brick
    - f. York Building Products
  2. Density Classification: Normal weight.

3. Size: Modular.
4. Actual Dimensions: 3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long.
5. Texture: Ground-face finish
6. Colors: As selected by Architect from manufacturer's full range.

## 2.5 MORTAR MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
  1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of Portland cement and hydrated lime containing no other ingredients.
- D. Masonry Cement: ASTM C 91/C 91M.
- E. Mortar Cement: ASTM C 1329/C 1329M.
- F. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979/C 979M. Use only pigments with a record of satisfactory performance in masonry mortar.
- G. Colored Cement Products: Packaged blend made from Portland cement and hydrated lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.
  1. Colored Portland Cement-Lime Mix:
  2. Colored Masonry Cement:
  3. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
  4. Pigments shall not exceed 10 percent of Portland cement by weight.
  5. Pigments shall not exceed 5 percent of cement by weight.
- H. Aggregate for Mortar: ASTM C 144.
  1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
  2. For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 (1.18 mm) sieve.
  3. White-Mortar Aggregates: Natural white sand or crushed white stone.
  4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.

- I. Cold-Weather Admixture: Non-chloride, noncorrosive, accelerating admixture complying with ASTM C 494/C 494M, Type C, and recommended by manufacturer for use in masonry mortar of composition indicated.
- J. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent from same manufacturer.
- K. Water: Potable.

## 2.6 TIES AND ANCHORS

- A. General: Ties and anchors shall extend at least 1-1/2 inches into veneer but with at least a 5/8-inch cover on outside face.
- B. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated:
  - 1. Mill-Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M, with ASTM A 641/A 641M, Class 1 coating.
  - 2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M, with ASTM A 153/A 153M, Class B-2 coating.
  - 3. Galvanized-Steel Sheet: ASTM A 653/A 653M, Commercial Steel, G60 (Z180) zinc coating.
  - 4. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
- C. Corrugated-Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 to 0.5 inch and an amplitude of 0.06 to 0.10 inch made from 0.060 inch thick, steel sheet, galvanized after fabrication.
- D. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
  - 1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls unless otherwise indicated.
  - 2. Tie Section: Triangular-shaped wire tie made from 0.25 inch diameter, hot-dip galvanized steel. Mill-galvanized wire may be used at interior walls unless otherwise indicated.
- E. Adjustable Anchors for Connecting to Concrete: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
  - 1. Connector Section: Dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.105 inch thick steel sheet, galvanized after fabrication.

- a. 4 inch thick galvanized-steel sheet may be used at interior walls unless otherwise indicated.
  2. Tie Section: Triangular-shaped wire tie made from 0.25 inch diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls unless otherwise indicated.
  3. Corrugated-Metal Ties: Metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 to 0.5 inch and an amplitude of 0.06 to 0.10 inch made from 0.060 inch thick, steel sheet, galvanized after fabrication, with dovetail tabs for inserting into dovetail slots in concrete.
    - a. 4 inch thick galvanized-steel sheet may be used at interior walls unless otherwise indicated.
- F. Adjustable Masonry-Veneer Anchors:
  1. General: Provide anchors that allow vertical adjustment but resist a 100-lbf (445-N) load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch.
  2. Fabricate sheet metal anchor sections and other sheet metal parts from 0.105 inch thick steel sheet, galvanized after fabrication
  3. Fabricate wire ties from 0.25 inch diameter, hot-dip galvanized-steel wire unless otherwise indicated.
  4. Fabricate wire connector sections from 0.25 inch diameter, hot-dip galvanized-steel wire.
  5. Contractor's Option: Unless otherwise indicated, provide any of the adjustable masonry-veneer anchors specified.
  6. Screw-Attached, Masonry-Veneer Anchors:
    - a. Wire tie and a gasketed sheet metal anchor section, 1-1/4 inches wide by 6 inches long, with screw holes top and bottom; top and bottom ends bent to form pronged legs of length to match thickness of insulation or sheathing; and raised rib-stiffened strap, 5/8 inch wide by 6 inches long, stamped into center to provide a slot between strap and base for inserting wire tie. Self-adhering, modified bituminous gasket fits behind anchor plate and extends beyond pronged legs.
    - b. Wire tie and a corrosion-resistant, self-drilling, eye-screw designed to receive wire tie. Eye-screw has spacer that seats directly against framing and is same thickness as sheathing and has gasketed washer head that covers hole in sheathing.
    - c. Connector section and a rib-stiffened, sheet metal anchor section with screw holes top and bottom, with projecting tabs having slotted holes for inserting vertical leg of connector section. Connector section consists of a rib-stiffened, sheet metal bent plate with down-turned leg designed to fit in anchor section slot and with integral tabs designed to engage continuous wire.
  7. Seismic Masonry-Veneer Anchors:

- a. Wire tie and a rib-stiffened, sheet metal anchor section with screw holes top and bottom, with projecting tabs having holes for inserting vertical legs of wire tie. Wire tie has sheet metal clip welded to it with integral tabs designed to engage continuous wire.
  - b. Connector section and a gasketed sheet metal anchor section, 1-1/4 inches wide by 6 inches long, with screw holes top and bottom; top and bottom ends bent to form pronged legs of length to match thickness of insulation or sheathing; and raised rib-stiffened strap, 5/8 inch wide by 6 inches long, stamped into center to provide a slot between strap and base for inserting connector section. Self-adhering, modified bituminous gasket fits behind anchor plate and extends beyond pronged legs. Connector section consists of a triangular wire tie and rigid PVC extrusion with snap-in grooves for inserting continuous wire.
8. Polymer-Coated, Steel Drill Screws for Steel Studs:
- a. ASTM C 954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 (4.83-mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours according to ASTM B 117.

## 2.7 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
1. Stainless Steel: ASTM A 240/A 240M or ASTM A 666, Type 304, 0.016 inch thick.
  2. Fabricate continuous flashings in sections 96 inches long minimum, but not exceeding 12 feet. Provide splice plates at joints of formed, smooth metal flashing.
  3. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
  4. Fabricate metal drip edges for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least 3 inches into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam sheds water.
  5. Fabricate metal expansion-joint strips from stainless steel to shapes indicated.
  6. Solder metal items at corners.
- B. Application: Unless otherwise indicated, use the following:
1. Where flashing is indicated to receive counterflashing, use metal flashing.
  2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
  3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a metal drip edge.



4. Where flashing is fully concealed, use metal flashing.
- C. Solder and Sealants for Sheet Metal Flashings:
    1. Solder for Stainless Steel: ASTM B 32, Grade Sn96, with acid flux of type recommended by stainless-steel sheet manufacturer.
    2. Elastomeric Sealant: ASTM C 920, chemically curing silicone sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and remain watertight.
  - D. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.
  - E. Termination Bars for Flexible Flashing: Aluminum or Stainless steel bars 1/8 inch by 1 inch.

## 2.8 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.
- B. Weep/Vent Products: Use one of the following unless otherwise indicated:
  1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.
  2. Aluminum Weep Hole/Vent: Units made from sheet aluminum, designed to fit into a head joint and consisting of a vertical channel, with louvers stamped in web and with a top flap to keep mortar out of the head joint; factory primed and painted before installation to comply with Section 099113 "Exterior Painting" in color selected by Architect.
- C. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
  1. Configuration: Provide one of the following:
    - a. Sheets or strips, full depth of cavity and installed to full height of cavity.
    - b. Sheets or strips not less than 3/4 inch thick and installed to full height of cavity with additional strips 4 inches (100 mm) high at weep holes and thick enough to fill entire depth of cavity and prevent weep holes from clogging with mortar.

## 2.9 MASONRY CLEANERS

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

## 2.10 MORTAR MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures unless otherwise indicated.
  - 1. Do not use calcium chloride in mortar or grout.
  - 2. Use Portland cement-lime mortar unless otherwise indicated.
  - 3. Add cold-weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Masonry: Comply with ASTM C 270, Property Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
  - 1. For masonry below grade or in contact with earth, use Type M.
  - 2. For exterior, above-grade, load-bearing and non-load-bearing walls and parapet walls; for interior load-bearing walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
  - 3. For interior non-load-bearing partitions, Type O may be used instead of Type N.
- D. Pigmented Mortar: Use colored cement product. Do not add pigments to colored cement products.
  - 1. Pigments shall not exceed 10 percent of Portland cement by weight.
  - 2. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
  - 3. Mix to match Architect's sample.
- E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
  - 1. Mix to match Architect's sample.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  - 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated
- B. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- C. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- D. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.
- E. Matching Existing Masonry: Match coursing, bonding, color, and texture of existing masonry.
- F. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested according to ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

### 3.3 TOLERANCES

- A. Dimensions and Locations of Elements:
  - 1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
  - 2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
  - 3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

### 3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond to match existing masonry construction; do not use units with less-than-nominal 4-inch horizontal face dimensions at corners or jambs.

- C. Stopping and Resuming Work: Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- E. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

### 3.5 MORTAR BEDDING AND JOINTING

- A. Lay masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
  - 1. At anchors and ties, fully bed units and fill cells with mortar as needed to fully embed anchors and ties in mortar.
- B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
  - 1. Space anchors as indicated, but not more than 24 inches o.c. vertically and 36 inches o.c. horizontally.

### 3.6 EXPANSION JOINTS

- A. General: Install expansion-joint materials in unit masonry as masonry progresses. Do not allow materials to span expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form expansion joints as follows:
  - 1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.
  - 2. Build flanges of factory-fabricated, expansion-joint units into masonry.
  - 3. Build in compressible joint fillers where indicated.
  - 4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Section 079200 "Joint Sealants."
- C. Provide horizontal, pressure-relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 079200 "Joint Sealants," but not less than 3/8 inch.
  - 1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

### 3.7 LİNTELS

- A. Install steel lintels where indicated.
- B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

### 3.8 FLASHING, WEEP HOLES, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.
- B. Install flashing as follows unless otherwise indicated:
  - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
  - 2. Extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least 8 inches; with upper edge tucked under weather-resistive barrier, lapping at least 4 inches. Fasten upper edge of flashing to sheathing through termination bar.
  - 3. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
  - 4. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1-1/2 inches or as recommended by flashing manufacturer, and seal lap with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
  - 5. Install metal drip edges with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant complying with requirements in Section 079200 "Joint Sealants" for application indicated.
  - 6. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.
  - 7. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
  - 8. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.
- C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

- D. Install weep holes in veneers in head joints of first course of masonry immediately above embedded flashing.
  - 1. Use specified weep/vent products to form weep holes.
  - 2. Space weep holes 24 inches o.c. unless otherwise indicated.
  - 3. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose-fill insulation.
- E. Place cavity drainage material in airspace behind veneers to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.
- F. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products to form vents.
  - 1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through-wall flashing and weep holes above horizontal blocking.

### 3.9 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Inspections: Special inspections according to Level B in TMS 402/ACI 530/ASCE 5.
  - 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
- C. Testing Prior to Construction: One set of tests.
- D. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.
- E. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
- F. Mortar Aggregate Ratio Test (Proportion Specification): For each mix provided, according to ASTM C 780.
- G. Mortar Test (Property Specification): For each mix provided, according to ASTM C 780. Test mortar for mortar air content and compressive strength.

### 3.10 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
  - 1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
  - 2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
  - 3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
  - 4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
  - 5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
  - 6. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
  - 7. Clean stone trim to comply with stone supplier's written instructions.
  - 8. Clean limestone units to comply with recommendations in ILI's "Indiana Limestone Handbook."

### 3.11 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above or recycled, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION



## SECTION 051200 - STRUCTURAL STEEL FRAMING

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Structural steel.
  - 2. Grout.
- B. Related Sections include the following:
  - 1. Division 01 Section "Quality Requirements" for independent testing agency procedures and administrative requirements.
  - 2. Division 09 Section "Painting" for surface preparation and priming.

#### 1.3 DEFINITIONS

- A. Structural Steel: Elements of structural-steel frame, as classified by AISC's "Code of Standard Practice for Steel Buildings and Bridges," that support design loads.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Show fabrication of structural-steel components.
  - 1. Include details of cuts, connections, splices, camber, holes, and other pertinent data.
  - 2. Include embedment drawings.
  - 3. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld.
  - 4. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical high-strength bolted connections.
  - 5. For structural-steel connections indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

- C. Delegated Design Submittal: For lintels, beams, girders, plates, angles and all other structural steel, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Welding certificates.
- E. Qualification Data: For Installer, fabricator, professional engineer, testing agency.
- F. Mill Test Reports: Signed by manufacturers certifying that the following products comply with requirements:
  - 1. Structural steel including chemical and physical properties.
  - 2. Bolts, nuts, and washers including mechanical properties and chemical analysis.
  - 3. Direct-tension indicators.
  - 4. Tension-control, high-strength bolt-nut-washer assemblies.
  - 5. Shear stud connectors.
  - 6. Shop primers.
  - 7. Nonshrink grout.
- G. Source quality-control test reports.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- B. Fabricator Qualifications: A qualified fabricator who participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category Cbd.
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P1, P2 & P3 or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
- D. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."
- E. Comply with applicable provisions of the following specifications and documents:
  - 1. AISC's "Code of Standard Practice for Steel Buildings and Bridges."
  - 2. AISC's "Seismic Provisions for Structural Steel Buildings" and "Supplement No. 2."
  - 3. AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design
  - 4. AISC's "Specification for the Design of Steel Hollow Structural Sections."
  - 5. AISC's "Specification for Allowable Stress Design of Single-Angle Members
  - 6. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
  - 1. Store fasteners in a protected place. Clean and re-lubricate bolts and nuts that become dry or rusty before use.
  - 2. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

## 1.7 COORDINATION

- A. Furnish anchorage items to be embedded in or attached to other construction without delaying the Work. Provide setting diagrams, sheet metal templates, instructions, and directions for installation.

## PART 2 PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design lintels, beams, girders, plates, angles and all other structural steel components.

### 2.2 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes: ASTM A 992, Grade 50.
- B. Channels, Angles, Shapes: ASTM A 36, unless otherwise noted.
- C. Plate and Bar: ASTM A 36, unless otherwise noted.
- D. Welding Electrodes: Comply with AWS requirements.

### 2.3 BOLTS, CONNECTORS, AND ANCHORS

- A. High-Strength Bolts, Nuts, and Washers: ASTM A 325 Type 1, heavy hex steel structural bolts; ASTM A 563 heavy hex carbon-steel nuts; and ASTM F 436 hardened carbon-steel washers.
  - 1. Finish: Plain.
  - 2. Direct-Tension Indicators: ASTM F 959, Type 325 compressible-washer type.
- B. Unheaded Anchor Rods: ASTM F 1554, Grade 36, weldable
  - 1. Configuration: Embedded Nut
  - 2. Nuts: ASTM A 563 heavy hex carbon steel.

3. Plate Washers: ASTM A 36/A 36M carbon steel.
  4. Washers: ASTM F 436 hardened carbon steel.
  5. Finish: Plain
- C. Headed Anchor Rods: ASTM F 1554, Grade 36, weldable, straight.
1. Nuts: ASTM A 563 heavy hex carbon steel.
  2. Plate Washers: ASTM A 36/A 36M carbon steel.
  3. Washers: ASTM F 436 hardened carbon steel.
  4. Finish: Plain.
- D. Threaded Rods: ASTM A36
1. Nuts: ASTM A 563 heavy hex carbon steel.
  2. Washers: ASTM F 436 hardened carbon steel.
  3. Finish: Plain
- E. Eye Bolts and Nuts: ASTM A 108, Grade 1030, cold-finished carbon steel.
- F. Sleeve Nuts: ASTM A 108, Grade 1018, cold-finished carbon steel.
- 2.4 PRIMER
- A. Primer: SSPC-Paint 25, Type I, iron oxide, zinc oxide, raw linseed oil, and alkyd.
- 2.5 GROUT
- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.
- 2.6 FABRICATION
- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC's "Code of Standard Practice for Steel Buildings and Bridges" and AISC's "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design.
1. Camber structural-steel members where indicated.
  2. Identify high-strength structural steel according to ASTM A 6/ A 6M and maintain markings until structural steel has been erected.
  3. Mark and match-mark materials for field assembly.
  4. Complete structural-steel assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting: Perform thermal cutting by machine to greatest extent possible.
1. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.

- C. Bolt Holes: Cut, drill, punch standard bolt holes perpendicular to metal surfaces.
- D. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- E. Cleaning: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 1, "Solvent Cleaning."
- F. Holes: Provide holes required for securing other work to structural steel and for passage of other work through steel framing members.
  - 1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
  - 2. Base-Plate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
  - 3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

## 2.7 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
  - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
  - 1. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
  - 2. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
  - 3. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances
    - a. Grind butt welds flush.
    - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

## 2.8 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
  - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
  - 2. Surfaces to be field welded.
  - 3. Surfaces to be high-strength bolted with slip-critical connections.

4. Surfaces to receive sprayed fire-resistive materials.
  5. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
1. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a dry film thickness of not less than 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
  2. Apply two coats of shop paint to inaccessible surfaces after assembly or erection. Change color of second coat to distinguish it from first.
- D. Painting: Apply a 1-coat, non-asphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils.
- E. Hot-Dipped Galvanizing: Galvanize all exterior steel structures in accordance with ASTM-A123.

## 2.9 SOURCE QUALITY CONTROL

- A. Correct deficiencies in Work that inspections indicate does not comply with the Contract Documents.
- B. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments, with steel erector present, for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

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

### 3.3 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- B. Base and Bearing Plates: Clean concrete and masonry-bearing surfaces of bond reducing materials and roughen surfaces prior to setting base and bearing plates. Clean bottom surface of base and bearing plates.
  - 1. Set base and bearing plates for structural members on wedges, shims, or setting nuts as required.
  - 2. Weld plate washers to top of base plate.
  - 3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of base or bearing plate before packing with grout.
  - 4. Promptly pack grout solidly between bearing surfaces and base or bearing plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel within AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- D. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
  - 1. Level and plumb individual members of structure.
  - 2. Make allowances for difference between temperature at time of erection and mean temperature when structure is completed and in service.
- E. Splice members only where indicated.
- F. Remove erection bolts on welded, architecturally exposed structural steel; fill holes with plug welds; and grind smooth at exposed surfaces.
- G. Do not use thermal cutting during erection.

- H. Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

### 3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
  - 1. Joint Type: Snug tightened.
- B. Weld Connections: Comply with AWS D1.1 for welding procedure specifications, tolerances, appearance, and quality of welds and for methods used in correcting welding work.
  - 1. Comply with AISC's "Code of Standard Practice for Steel Buildings and Bridges" and "Specification for Structural Steel Buildings--Allowable Stress Design and Plastic Design" for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
  - 2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
  - 3. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances of AISC's "Code of Standard Practice for Steel Buildings and Bridges" for mill material.
  - 4. Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent weld show-through on exposed steel surfaces.
    - a. Grind butt welds flush.
    - b. Grind or fill exposed fillet welds to smooth profile. Dress exposed welds.

### 3.5 FIELD QUALITY CONTROL

- A. Bolted Connections: Shop-bolted connections will be tested and inspected according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- B. Welded Connections: Field welds will be visually inspected according to AWS D1.1.
- C. Correct deficiencies in Work that inspections indicate does not comply with the Contract Documents.

### 3.6 REPAIRS AND PROTECTION

- A. Repair damaged galvanized coatings on galvanized items with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
- B. Touchup Painting: After installation, promptly clean, prepare, and prime or reprime field connections, rust spots, and abraded surfaces of prime-painted joists and accessories, bearing plates, and abutting structural steel.



1. Clean and prepare surfaces by SSPC-SP 2 hand-tool cleaning or SSPC-SP 3 power-tool cleaning.
  2. Apply a compatible primer of same type as shop primer used on adjacent surfaces.
- C. Touchup Painting: Cleaning and touchup painting are specified in Division 9 painting Sections.

END OF SECTION

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## SECTION 055213 - PIPE AND TUBE RAILINGS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Aluminum railings.

#### 1.2 COORDINATION

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

#### 1.3 ACTION SUBMITTALS

- A. Product Data:
  - 1. Manufacturer's product lines of mechanically connected railings.
  - 2. Fasteners.
  - 3. Post-installed anchors.
  - 4. Handrail brackets.
  - 5. Nonshrink, nonmetallic grout.
  - 6. Anchoring cement.
  - 7. Metal finishes.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
- C. Samples for Verification: For each type of exposed finish required.
  - 1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters, including finish.
  - 2. Fittings and brackets.
  - 3. Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.
- D. Delegated Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For delegated design professional engineer.
- B. Welding certificates.
- C. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.
- D. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

#### 1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
  - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.

#### 1.7 FIELD CONDITIONS

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

### PART 2 PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design railings, including attachment to building construction.
- B. Structural Performance: Railings, including attachment to building construction, withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
  - 1. Handrails and Top Rails of Guards:
    - a. Uniform load of 50 lbf/ ft. applied in any direction.
    - b. Concentrated load of 200 lbf applied in any direction.
    - c. Uniform and concentrated loads need not be assumed to act concurrently.
  - 2. Infill of Guards:

- a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
  - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

## 2.2 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.
  - 1. Provide type of bracket with flange tapped for concealed anchorage to threaded hanger bolt and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

## 2.3 ALUMINUM RAILINGS

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.
- B. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.
- C. Extruded Bars and Tubing: ASTM B221 Alloy 6063-T5/T52.
- D. Extruded Structural Pipe and Round Tubing: ASTM B429/B429M, Alloy 6063-T6.
  - 1. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.
- E. Drawn Seamless Tubing: ASTM B210/B210M, Alloy 6063-T832.
- F. Plate and Sheet: ASTM B209, Alloy 6061-T6.
- G. Die and Hand Forgings: ASTM B247, Alloy 6061-T6.
- H. Castings: ASTM B26/B26M, Alloy A356.0-T6.

## 2.4 FASTENERS

- A. Fastener Materials:
  - 1. Aluminum Railing Components: Type 316 stainless steel fasteners.
  - 2. Finish exposed fasteners to match appearance, including color and texture, of railings.

- 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 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 exposed fasteners are unavoidable or are the standard fastening method for railings indicated.
- D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193.
  - 1. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 2 stainless steel bolts, ASTM F593, and nuts, ASTM F594.

## 2.5 MISCELLANEOUS MATERIALS

- A. Handrail Brackets: Cast aluminum, center of handrail 2-1/2 inches from face of railing or wall, unless otherwise noted.
- B. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded.
  - 1. For aluminum railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.
- C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout, complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- 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.
  - 1. Water-Resistant Product: At exterior locations, provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

## 2.6 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. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations.

1. Clearly mark units for reassembly and coordinated installation.
2. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately.
  1. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated.
  2. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water.
  1. Provide weep holes where water may accumulate.
  2. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with welded connections unless otherwise indicated.
- H. 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 welds to comply with NOMMA's "Voluntary Joint Finish Standards" for Finish #1 welds; ornamental quality with no evidence of a welded joint.
- I. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
- J. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
  1. Fabricate splice joints for field connection, using an epoxy structural adhesive, if this is manufacturer's standard splicing method.
- K. Form changes in direction as follows:
  1. By bending to smallest radius that will not result in distortion of railing member.
- L. 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.
- M. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.

- N. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- O. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work 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.
- P. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work.
  - 1. Fabricate anchorage devices capable of withstanding loads imposed by railings.
  - 2. Coordinate anchorage devices with supporting structure.
- Q. For railing posts set in concrete, provide sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.

## 2.7 ALUMINUM FINISHES

- A. 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 unacceptable. 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.
- B. Color: As selected by Architect from full range of industry colors and color densities.
  - 1. Clear Anodic Finish: AAMA 611, AA-M12C22A41.
  - 2. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44.

## PART 3 EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Perform cutting, drilling, and fitting required for installing railings.
  - 1. Fit exposed connections together to form tight, hairline joints.
  - 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
  - 3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
  - 4. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.



5. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
  6. 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.
- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
1. Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- C. 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.

### 3.2 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws, using plastic cement filler colored to match finish of railings.
- B. 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.
- C. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve, extending 2 inches beyond joint on either side; fasten internal sleeve securely to one side; and locate joint within 6 inches of post.

### 3.3 ANCHORING POSTS

- A. Use pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions.
- C. Cover anchorage joint with flange of same metal as post, welded to post after placing anchoring material.

- D. Anchor posts to metal surfaces with flanges, angle type, or floor type, as required by conditions, connected to posts and to metal supporting members as follows:
  - 1. For aluminum railings, attach posts as indicated, using fittings designed and engineered for this purpose.

### 3.4 ATTACHING RAILINGS

- A. Attach handrails to walls with wall brackets. Provide brackets with 1-1/2-inch clearance from inside face of handrail and finished wall surface, unless otherwise noted.
  - 1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.
  - 2. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- B. Secure wall brackets to building construction as follows:
  - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
  - 2. For hollow masonry anchorage, use toggle bolts.
  - 3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.

### 3.5 CLEANING

- A. Clean aluminum by washing thoroughly with clean water and soap and rinsing with clean water.

### 3.6 PROTECTION

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

END OF SECTION

## SECTION 061053 - MISCELLANEOUS ROUGH CARPENTRY

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following:
  - 1. Wood blocking and nailers.
  - 2. Wood furring and grounds.
  - 3. Wood sleepers.
  - 4. Plywood backing panels.

#### 1.3 DEFINITIONS

- A. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) or greater but less than 5 inches nominal (114 mm actual) in least dimension.
- B. Lumber grading agencies, and the abbreviations used to reference them, include the following:
  - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
  - 2. NHLA: National Hardwood Lumber Association.
  - 3. NLGA: National Lumber Grades Authority.
  - 4. SPIB: The Southern Pine Inspection Bureau.
  - 5. WCLIB: West Coast Lumber Inspection Bureau.
  - 6. WWPA: Western Wood Products Association.

#### 1.4 SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
  - 1. Include data for wood-preserved treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Indicate type of preservative used and net amount of preservative retained.

2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
  3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
  4. Include copies of warranties from chemical treatment manufacturers for each type of treatment.
  5. Product Data: For adhesives, including printed statement of VOC content.
  6. Product Data: For composite-wood products, documentation indicating that product contains no urea formaldehyde.
- B. Research/Evaluation Reports: For the following, showing compliance with building code in effect for Project:
1. Preservative-treated wood.
  2. Fire-retardant-treated wood.

## 1.5 QUALITY ASSURANCE

- A. Forest Certification: For the following wood products, provide materials produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD-01-001, "FSC Principles and Criteria for Forest Stewardship:"
1. Dimension lumber framing.
  2. Miscellaneous lumber.
  3. Interior wood trim.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.
- B. Deliver interior wood materials that are to be exposed to view only after building is enclosed and weatherproof, wet work other than painting is dry, and HVAC system is operating and maintaining temperature and humidity at occupancy levels.

## PART 2 PRODUCTS

### 2.1 WOOD PRODUCTS, GENERAL

- A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that complies with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
  - 1. Factory mark each piece of lumber with grade stamp of grading agency.
  - 2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
  - 3. Provide dressed lumber, S4S, unless otherwise indicated.

## 2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWP C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWP C31 with inorganic boron (SBX.)
  - 1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Kiln-dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not comply with requirements for untreated material.
- C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.
- D. Application: Treat items indicated on Drawings, and the following:
  - 1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
  - 2. Wood sills, sleepers, blocking, furring, and similar concealed members in contact with masonry or concrete.
  - 3. Wood framing members that are less than 18 inches (460 mm) above the ground in crawl spaces or unexcavated areas.
  - 4. Wood floor plates that are installed over concrete slabs-on-grade.

## 2.3 FIRE-RETARDANT-TREATED MATERIALS

- A. General: Comply with performance requirements in AWP C20 (lumber) and AWP C27 (plywood).
  - 1. Use treatment that does not promote corrosion of metal fasteners.
  - 2. Use Exterior type for exterior locations and where indicated.
  - 3. Use Interior Type A, High Temperature (HT) for enclosed roof framing, framing in attic spaces, and where indicated.

4. Use Interior Type A, unless otherwise indicated.
- B. Identify fire-retardant-treated wood with appropriate classification marking of testing and inspecting agency acceptable to authorities having jurisdiction.
  1. For exposed lumber indicated to receive a stained or natural finish, omit marking and provide certificates of treatment compliance issued by inspection agency.
- C. For exposed items indicated to receive a stained or natural finish, use chemical formulations that do not bleed through, contain colorants, or otherwise adversely affect finishes.
- D. Application: Treat items indicated on Drawings, and the following:
  1. Concealed blocking.
  2. Plywood backing panels.

## 2.4 DIMENSION LUMBER FRAMING

- A. Maximum Moisture Content: 15 percent for 2 inch nominal (38 mm actual) thickness or less, 19 percent for more than 2 inch nominal (38 mm actual) thickness.
- B. Other Framing: Construction, Stud, or No. 3 grade and the following species:
  1. Hem-fir (north); NLGA.
  2. Southern pine; SPIB.
  3. Douglas fir-larch; WCLIB or WWPA.
  4. Mixed southern pine; SPIB.
  5. Spruce-pine-fir; NLGA.
  6. Douglas fir-south; WWPA.
  7. Hem-fir; WCLIB or WWPA.
  8. Douglas fir-larch (north); NLGA.
  9. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

## 2.5 MISCELLANEOUS LUMBER

- A. General: Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
  1. Blocking.
  2. Nailers.
  3. Cants.
  4. Furring.
  5. Grounds.
- B. For items of dimension lumber size, provide Construction or No. 2 grade lumber with 19 percent maximum moisture content of any species.

- C. For items of dimension lumber size, provide Standard, Stud, or No. 3 grade lumber with 19 percent maximum moisture content and the following species:
  - 1. Hem-fir (north); NLGA.
  - 2. Mixed southern pine; SPIB.
  - 3. Spruce-pine-fir; NLGA.
  - 4. Hem-fir; WCLIB, or WWPA.
  - 5. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.
  - 6. Western woods; WCLIB or WWPA.
  - 7. Northern species; NLGA.
  - 8. Eastern softwoods; NeLMA.
- D. For exposed boards, provide lumber with 15 percent maximum moisture content and any of the following species and grades:
  - 1. Eastern white pine, Idaho white, lodgepole, ponderosa, or sugar pine; Standard or No. 3 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
  - 2. Mixed southern pine, No. 2 grade; SPIB.
  - 3. Hem-fir or hem-fir (north), Construction or No. 2 Common grade; NLGA, WCLIB, or WWPA.
  - 4. Spruce-pine-fir (south) or spruce-pine-fir, Construction or No. 2 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
- E. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:
  - 1. Mixed southern pine, No. 2 grade; SPIB.
  - 2. Hem-fir or hem-fir (north), Standard or 3 Common grade; NLGA, WCLIB, or WWPA.
  - 3. Spruce-pine-fir (south) or spruce-pine-fir, Standard or 3 Common grade; NeLMA, NLGA, WCLIB, or WWPA.
  - 4. Eastern softwoods, No. 3 Common grade; NELMA.
  - 5. Northern species, No. 3 Common grade; NLGA.
  - 6. Western woods, Standard or No. 3 Common grade; WCLIB or WWPA.
- F. For blocking not used for attachment of other construction Utility, Stud, or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.
- G. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.
- H. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent-over nails and damage to paneling.

## 2.6 PLYWOOD BACKING PANELS

- A. Equipment and Casework Backing Panels: DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2 inch (13 mm) nominal thickness that contains no urea formaldehyde.

## 2.7 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
  - 1. Where carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
- B. Nails, Brads, and Staples: ASTM F 1667.
- C. Power-Driven Fasteners: NES NER-272.
- D. Wood Screws: ASME B18.6.1.
- E. Screws for Fastening to Cold-Formed Metal Framing: ASTM C 954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
- F. Lag Bolts: ASME B18.2.1 (ASME B18.2.3.8M).
- G. Bolts: Steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers.
- H. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to 6 times the load imposed when installed in unit masonry assemblies and equal to 4 times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing and inspecting agency.

## 2.8 MISCELLANEOUS MATERIALS

- A. Adhesives for Gluing Furring to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.
  - 1. Use adhesives that have a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## PART 3 EXECUTION

### 3.1 INSTALLATION, GENERAL



- A. Set carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.
- B. Framing Standard: Comply with AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- C. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, trim and partition mounted or supported equipment including cabinets and accessories.
- D. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
- E. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.
- F. Comply with AWP A M4 for applying field treatment to cut surfaces of preservative-treated lumber.
  - 1. Use inorganic boron for items that are continuously protected from liquid water.
  - 2. Use copper naphthenate for items not continuously protected from liquid water.
- G. Securely attach carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
  - 1. NES NER-272 for power-driven fasteners.
  - 2. Table 2304.9.1, "Fastening Schedule," in ICC's International Building Code.
  - 3. Table 23-II-B-1, "Nailing Schedule," and Table 23-II-B-2, "Wood Structural Panel Roof Sheathing Nailing Schedule," in ICBO's Uniform Building Code.
  - 4. Table 2305.2, "Fastening Schedule," in BOCA's BOCA National Building Code.
  - 5. Table 2306.1, "Fastening Schedule," in SBCCI's Standard Building Code.
  - 6. Table R602.3(1), "Fastener Schedule for Structural Members," and Table R602.3(2), "Alternate Attachments," in ICC's International Residential Code for One- and Two-Family Dwellings.
  - 7. Table 602.3(1), "Fastener Schedule for Structural Members," and Table 602.3(2), "Alternate Attachments," in ICC's International One and Two Family Dwelling Code.
- H. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

### 3.2 WOOD GROUND, BLOCKING, AND NAILER INSTALLATION

- A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
- B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.
- C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

### 3.3 WOOD FURRING INSTALLATION

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood or Hardboard Paneling: Install 1 by 3 inch nominal (19 by 63 mm actual) size furring horizontally at 24 inches (610 mm) o.c.
- C. Furring to Receive Gypsum Board: Install 1 by 2 inch nominal (19 by 38 mm actual) size furring vertically at 16 inches (406 mm) o.c.

### 3.4 PROTECTION

- A. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION

## SECTION 061600 - SHEATHING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Wall sheathing.
  - 2. Roof sheathing.
  - 3. Specialty sheathing.
  - 4. Subflooring and underlayment.
  - 5. Sheathing joint-and-penetration treatment materials.

#### 1.2 PREINSTALLATION MEETINGS

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

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of process and factory-fabricated product. Indicate component materials and dimensions and include construction and application details.
  - 1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Indicate type of preservative used and net amount of preservative retained.
  - 2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated plywood complies with requirements. Include physical properties of treated materials.
  - 3. For fire-retardant treatments, include physical properties of treated plywood both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency in accordance with ASTM D5516.
  - 4. For products receiving waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
- B. Shop Drawings: For sheathing assemblies.
  - 1. Show locations and extent of sheathing, accessories, and assemblies specific to Project conditions.
  - 2. Include details for sheathing joints and cracks, counterflashing strips, penetrations, inside and outside corners, terminations, and tie-ins with adjoining construction.
  - 3. Include details of interfaces with other materials that form part of air barrier.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: From sheathing manufacturer, certifying compatibility of sheathing accessory materials with Project materials that connect to or that come in contact with the sheathing.
- B. Product Test Reports: For sheathing assembly, indicating compliance with specified requirements, for tests performed by a qualified testing agency.
- C. Evaluation Reports: For the following, from ICC-ES:
  - 1. Wood-preservative-treated plywood.
  - 2. Fire-retardant-treated plywood.
- D. Field quality-control reports.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer of sheathing.
  - 1. Installer is to be licensed by ABAA in accordance with ABAA's Quality Assurance Program and is to employ ABAA-certified installers and supervisors on Project.
- B. Testing Agency Qualifications:
  - 1. For testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.
  - 2. For testing and inspecting agency providing tests and inspections related to sheathing: an independent agency, qualified in accordance with ASTM E329 for testing indicated, and certified by Air Barrier Association of America, Inc.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Stack panels flat with spacers beneath and between each bundle to provide air circulation. Protect sheathing from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

### PART 2 PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance Ratings: As tested in accordance with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Fire-Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.
- B. Sheathing Performance: sheathing assembly, and seals with adjacent construction, are to be capable of performing as a continuous air barrier and as a liquid-water drainage plane flashed to discharge to the exterior incidental condensation or water penetration. Air-barrier assemblies are to be capable of accommodating substrate movement and of sealing substrate expansion and control joints, construction material changes, penetrations, tie-ins to installed waterproofing, tie-ins to other installed air barriers, and transitions at perimeter conditions without deterioration and air leakage exceeding specified limits.

## 2.2 WOOD PANEL PRODUCTS

- A. Emissions: Products are to meet the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- B. Thickness: As needed to comply with requirements specified, but not less than thickness indicated.
- C. Factory mark panels to indicate compliance with applicable standard.

## 2.3 PRESERVATIVE-TREATED PLYWOOD

- A. Preservative Treatment by Pressure Process: AWPAC U1; Use Category UC3b for exterior construction items not in contact with ground and Use Category UC4a for exterior construction items in contact with ground.
  1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.
- B. Mark plywood with appropriate classification marking of an inspection agency acceptable to authorities having jurisdiction.
- C. Application: Treat all plywood unless otherwise indicated.

## 2.4 WALL SHEATHING

- A. Plywood Sheathing: Either DOC PS 1 or DOC PS 2 sheathing.
  1. Span Rating: Not less than 16/0.
  2. Nominal Thickness: Not less than 11/32 inch.
- B. Oriented-Strand-Board Sheathing: DOC PS 2 sheathing.
  1. Span Rating: Not less than 16/0.
  2. Nominal Thickness: Not less than 5/16 inch.

- C. Glass-Mat Gypsum Sheathing, Walls: ASTM C1177/C1177M.
  - 1. Type and Thickness: Type X, 5/8 inch thick.

## 2.5 ROOF SHEATHING

- A. Plywood Sheathing: Either DOC PS 1 or DOC PS 2 sheathing.
  - 1. Span Rating: Not less than 16/0.
  - 2. Nominal Thickness: Not less than 15/32 inch.
- B. Oriented-Strand-Board Sheathing: DOC PS 2 sheathing.
  - 1. Span Rating: Not less than 16/0.
  - 2. Nominal Thickness: Not less than 7/16 inch.

## 2.6 SPECIALTY SHEATHING

- A. Exterior Insulated Sheathing with Moisture and Air Protection:
  - 1. Basis of Design Product: Where indicated, subject to compliance with requirements, provide Zip System Insulated R-Sheathing manufactured by Huber Engineered Woods, or a comparable product by one of the following:
    - a. Kingspan Group
    - b. LP Building Solutions
    - c. Owens Corning
    - d. Ox Engineered Products
  - 2. Size: 48 inch by 96 inch minimum boards.
  - 3. R-Value: Varies per application.
    - a. Exterior Walls: Single layer, R-7.5 minimum, 2 inch thick minimum.
    - b. Roofs: Triple layer, staged assembly, R-30 minimum, 6 1/2 inch thick minimum.
  - 4. Air Barrier Rating: ASTM E 2178 <0.02 L/S\*m2 @ 75 Pa or ASTM E 2357 <0.2 L/S\*m2 @ 75 Pa

## 2.7 SUBFLOORING AND UNDERLAYMENT

- A. Plywood Combination Subfloor-Underlayment: DOC PS 1 single-floor panels.
  - 1. Span Rating: Not less than 16.
  - 2. Nominal Thickness: Not less than 23/32 inch.
  - 3. Edge Detail: Square.
  - 4. Surface Finish: Fully sanded face.
- B. Oriented-Strand-Board Combination Subfloor-Underlayment: DOC PS 2, Exposure 1 single-floor panels.
  - 1. Span Rating: Not less than 16.
  - 2. Nominal Thickness: Not less than 23/32 inch.

3. Edge Detail: Square.
4. Surface Finish: Fully sanded face.

## 2.8 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
  1. For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M.
  2. For roof and wall sheathing, provide fasteners with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Screws for Fastening Sheathing to Wood Framing: ASTM C1002.
- E. Screws for Fastening Wood Structural Panels to Cold-Formed Metal Framing: ASTM C954, except with wafer heads and reamer wings, length as recommended by screw manufacturer for material being fastened.
- F. Screws for Fastening Gypsum Sheathing to Cold-Formed Metal Framing: Steel drill screws, in length recommended by sheathing manufacturer for thickness of sheathing to be attached.
  1. For steel framing less than 0.0329 inch thick, use screws that comply with ASTM C1002.
  2. For steel framing from 0.033 to 0.112 inch thick, use screws that comply with ASTM C954.
- G. Screws for Fastening Composite Nail Base Insulated Roof Sheathing to Metal Roof Deck: Steel drill screws, in type and length recommended by sheathing manufacturer for thickness of sheathing to be attached, with organic-polymer or other corrosion-protective coating having a salt-spray resistance of more than 800 hours in accordance with ASTM B117. Provide washers or plates if recommended by sheathing manufacturer.

## 2.9 SHEATHING JOINT-AND-PENETRATION TREATMENT MATERIALS

- A. Sealant for Glass-Mat Gypsum Sheathing: Silicone emulsion sealant complying with ASTM C834, compatible with sheathing tape and sheathing and recommended by tape and sheathing manufacturers for use with glass-fiber sheathing tape and for covering exposed fasteners.

1. Sheathing Tape: Self-adhering glass-fiber tape, minimum 2 inches wide, 10 by 10 or 10 by 20 threads/inch of type recommended by sheathing and tape manufacturers for use with silicone emulsion sealant in sealing joints in glass-mat gypsum sheathing and with a history of successful in-service use.

## 2.10 MISCELLANEOUS MATERIALS

- A. Adhesives for Field Gluing Panels to Wood Framing: Formulation complying with ASTM D3498 that is approved for use with type of construction panel indicated by manufacturers of both adhesives and panels.

## PART 3 EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate by fastening as indicated, complying with the following:
  1. Table 2304.10.1, "Fastening Schedule," in the ICC's International Building Code.
  2. ICC-ES evaluation report for fastener.
- D. Use common wire nails unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections. Install fasteners without splitting wood.
- E. Coordinate wall and roof sheathing installation with flashing and joint-sealant installation so these materials are installed in sequence and manner that prevent exterior moisture from passing through completed assembly.
- F. Do not bridge building expansion joints; cut and space edges of panels to match spacing of structural support elements.
- G. Coordinate sheathing installation with installation of materials installed over sheathing so sheathing is not exposed to precipitation or left exposed at end of the workday when rain is forecast.

### 3.2 INSTALLATION OF WOOD STRUCTURAL PANEL

- A. General: Comply with applicable recommendations in APA Form No. E30, "Engineered Wood Construction Guide," for types of structural-use panels and applications indicated.



- B. Fastening Methods: Fasten panels as indicated below:
  - 1. Combination Subfloor-Underlayment:
    - a. Glue and nail to wood framing.
    - b. Screw to cold-formed metal framing.
    - c. Space panels 1/8 inch apart at edges and ends.
    - d. Fill and sand edge joints of underlayment receiving resilient flooring immediately before installing flooring.
  - 2. Wall and Roof Sheathing:
    - a. Nail to wood framing. Apply a continuous bead of glue to framing members at edges of wall sheathing panels.
    - b. Screw to cold-formed metal framing.
    - c. Space panels 1/8 inch apart at edges and ends.

### 3.3 INSTALLATION OF GYPSUM SHEATHING

- A. Comply with GA-253 and with manufacturer's written instructions.
  - 1. Fasten gypsum sheathing to wood framing with nails or screws.
  - 2. Fasten gypsum sheathing to cold-formed metal framing with screws.
  - 3. Install panels with a 3/8-inch gap where non-load-bearing construction abuts structural elements.
  - 4. Install panels with a 1/4-inch gap where they abut masonry or similar materials that might retain moisture, to prevent wicking.
- B. Apply fasteners so heads bear tightly against face of sheathing, but do not cut into facing.
- C. Horizontal Installation: Install sheathing with V-grooved edge down and tongue edge up. Interlock tongue with groove to bring long edges in contact with edges of adjacent panels without forcing. Abut ends over centers of studs, and stagger end joints of adjacent panels not less than one stud spacing. Attach at perimeter and within field of panel to each stud.
  - 1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels.
  - 2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.
- D. Vertical Installation: Install vertical edges centered over studs. Abut ends and edges with those of adjacent panels. Attach at perimeter and within field of panel to each stud.
  - 1. Space fasteners approximately 8 inches o.c. and set back a minimum of 3/8 inch from edges and ends of panels.

2. For sheathing under stucco cladding, panels may be initially tacked in place with screws if overlying self-furring metal lath is screw-attached through sheathing to studs immediately after sheathing is installed.
- E. Seal sheathing joints according to sheathing manufacturer's written instructions.
1. Apply elastomeric sealant to joints and fasteners and trowel flat. Apply sufficient amount of sealant to completely cover joints and fasteners after troweling. Seal other penetrations and openings.
  2. Apply glass-fiber sheathing tape to glass-mat gypsum sheathing joints and apply and trowel sealant to embed entire face of tape in sealant. Apply sealant to exposed fasteners with a trowel so fasteners are completely covered. Seal other penetrations and openings.
- F. Sheathing:
1. Install accessory materials according to sheathing manufacturer's written instructions and details to form a seal with adjacent construction, to seal fasteners, and ensure continuity of air and water barrier.
    - a. Coordinate the installation of sheathing with installation of roofing membrane and base flashing to ensure continuity of air barrier with roofing membrane.
    - b. Install transition strip on roofing membrane or base flashing, so that a minimum of 3 inches of coverage is achieved over each substrate.
  2. Connect and seal sheathing material continuously to air barriers specified under other Sections as well as to roofing-membrane air barrier, concrete below-grade structures, floor-to-floor construction, exterior glazing and window systems, glazed curtain-wall systems, storefront systems, exterior louvers, exterior door framing, and other construction used in exterior wall openings, using accessory materials.
  3. Apply joint sealants forming part of air-barrier assembly within manufacturer's recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
  4. Wall Openings: Prime concealed, perimeter frame surfaces of windows, curtain walls, storefronts, and doors. Apply transition strip or preformed silicone extrusion, so that a minimum of 3 inches of coverage is achieved over each substrate. Maintain 3 inches of full contact over firm bearing to perimeter frames, with not less than 1 inch of full contact.
    - a. Transition Strip: Roll firmly to enhance adhesion.
    - b. Preformed Silicone Extrusion: Set in full bed of silicone sealant applied to walls, frame, and air-barrier material.
  5. Fill gaps in perimeter frame surfaces of windows, curtain walls, storefronts, doors, and miscellaneous penetrations of sheathing material with foam sealant.
  6. Seal strips and transition strips around masonry reinforcing or ties and penetrations with termination mastic.

7. Seal top of through-wall flashings to sheathing with an additional 6-inch wide, transition strip.
8. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
9. Repair punctures, voids, and deficient lapped seams in strips and transition strips extending 6 inches beyond repaired areas in strip direction.

### 3.4 FIELD QUALITY CONTROL

- A. ABAA Quality Assurance Program: Perform examinations, preparation, installation, testing, and inspections under ABAA's Quality Assurance Program.
- B. Testing and Inspecting Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Inspections: sheathing, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
  1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
  2. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
  3. Termination mastic has been applied on cut edges.
  4. Strips and transition strips have been firmly adhered to substrate.
  5. Compatible materials have been used.
  6. Transitions at changes in direction and structural support at gaps have been provided.
  7. Connections between assemblies (sheathing and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
  8. All penetrations have been sealed.
- D. Sheathing and air barriers will be considered defective if they do not pass inspections.
- E. Repair damage to sheathing and air barriers caused by testing; follow manufacturer's written instructions.
- F. Prepare test and inspection reports.

END OF SECTION

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## SECTION 072100 - THERMAL INSULATION

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Foam-plastic board insulation.
  - 2. Mineral-wool blanket insulation.
  - 3. Spray-applied cellulosic insulation.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Foam-plastic board insulation.
  - 2. Mineral-wool blanket insulation.
  - 3. Spray-applied cellulosic insulation.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Installer's Certification: Listing type, manufacturer, and R-value of insulation installed in each element of the building thermal envelope.
  - 1. For blown-in or sprayed fiberglass and cellulosic-fiber loose-fill insulation, indicate initial installed thickness, settled thickness, settled R-value, installed density, coverage area, and number of bags installed.
  - 2. Sign, date, and post the certification in a conspicuous location on Project site.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Research Reports: For foam-plastic insulation, from ICC-ES.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

- B. Protect foam-plastic board insulation as follows:
  - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
  - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site until just before installation time.
  - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

## PART 2 PRODUCTS

### 2.1 EXTRUDED POLYSTYRENE FOAM-PLASTIC BOARD INSULATION

- A. Extruded Polystyrene Board Insulation, Type IV for Exterior Wall Assemblies.  
ASTM C578, Type IV, 30-psi minimum compressive strength; unfaced.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide products manufactured by Owens Corning, or comparable product by one of the following:
    - a. BASF Corporation
    - b. DiversiFoam Products.
    - c. Gaco Western, Inc.
    - d. Johns Manville.
    - e. Kingspan Products.
    - f. Knauf Insulation.
    - g. Resisto, a Division of Soprema.
    - h. Rockwool Products.
    - i. The Dow Chemical Company.
  - 2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
  - 3. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.
  - 4. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly.
- B. Extruded Polystyrene Board Insulation, Type V for Below-Grade Applications.  
ASTM C578, Type V, 100-psi minimum compressive strength.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide products manufactured by Owens Corning, or comparable product by one of the following:
    - a. BASF Corporation
    - b. DiversiFoam Products.
    - c. Gaco Western, Inc.
    - d. Johns Manville.

- e. Kingspan Products.
  - f. Knauf Insulation.
  - g. Resisto, a Division of Soprema.
  - h. Rockwool Products.
  - i. The Dow Chemical Company.
2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 450 when tested in accordance with ASTM E84.

## 2.2 MINERAL-WOOL BLANKET INSULATION

- A. Mineral-Wool Blanket Insulation, Unfaced for Cavities in Interior and Exterior Walls and Partitions. ASTM C665, Type I (blankets without membrane facing); consisting of fibers; passing ASTM E136 for combustion characteristics.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide products manufactured by Rockwool Products, or comparable product by one of the following:
    - a. BASF Corporation
    - b. DiversiFoam Products.
    - c. Gaco Western, Inc.
    - d. Johns Manville.
    - e. Kingspan Products.
    - f. Knauf Insulation.
    - g. Owens Corning.
    - h. Resisto, a Division of Soprema.
    - i. The Dow Chemical Company.
  2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
  3. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.

## 2.3 SPRAY-APPLIED CELLULOSIC INSULATION

- A. Self-Supported, Spray-Applied Cellulosic Insulation for Exterior Wall Assemblies. ASTM C1149, Type II (materials containing a dry adhesive activated by water during installation; intended only for enclosed or covered applications, chemically treated for flame-resistance, processing, and handling characteristics).
  1. Basis-of-Design Product: Subject to compliance with requirements, provide products manufactured by BASF Corporation, or comparable product by one of the following:
    - a. DiversiFoam Products.
    - b. Gaco Western, Inc.

- c. Johns Manville.
- d. Kingspan Products.
- e. Knauf Insulation.
- f. Owens Corning.
- g. Resisto, a Division of Soprema.
- h. Rockwool Products.
- i. The Dow Chemical Company.

## 2.4 INSULATION FASTENERS

- A. Adhesively Attached, Spindle-Type Anchors: Plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.
  - 1. Plate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
  - 2. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch in diameter; length to suit depth of insulation.
- B. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches square or in diameter.
- C. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 1 inch minimum between face of insulation and substrate to which anchor is attached.
- D. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

## 2.5 ACCESSORIES

- A. Insulation for Miscellaneous Voids:
  - 1. Glass-Fiber Insulation: ASTM C764, Type II, loose fill; with maximum flame-spread and smoke-developed indexes of 5, per ASTM E84.
  - 2. Spray Polyurethane Foam Insulation: ASTM C1029, Type II, closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84.
  - 3. Polyurethane Pour-In-Place Insulation: Closed cell, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E84, specifically formulated for pour-in-place applications.
- B. Adhesive for Bonding Insulation: Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.



- C. Eave Ventilation Troughs: Preformed, rigid fiberboard or plastic sheets designed and sized to fit between roof framing members and to provide ventilation between insulated attic spaces and vented eaves.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation, including removing projections capable of puncturing insulation or vapor retarders, or that interfere with insulation attachment.

### 3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Install insulation with manufacturer's R-value label exposed after insulation is installed.
- D. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- E. Provide sizes to fit applications and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

### 3.3 INSTALLATION OF SLAB INSULATION

- A. On vertical slab edge and foundation surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
  - 1. Extend insulation full depth of vertical face of slab edge and interior foundation wall surface, where indicated in drawings.
- B. On horizontal surfaces, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
  - 1. Extend insulation beneath entire surface of slab on grade assemblies, including but not limited to slabs and aprons containing radiant heating.

### 3.4 INSTALLATION OF FOUNDATION WALL INSULATION

- A. Butt panels together for tight fit.

- B. Anchor Installation: Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
  - 1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions.
  - 2. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application.
  - 3. Apply insulation standoffs to each spindle to create cavity width indicated on Drawings between concrete substrate and insulation.
  - 4. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation.
  - 5. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.
- C. Adhesive Installation: Install with adhesive or press into tacky waterproofing or dampproofing according to manufacturer's written instructions.

### 3.5 INSTALLATION OF INSULATION IN FRAMED CONSTRUCTION

- A. Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
  - 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
  - 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
  - 3. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
  - 4. For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
- B. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
  - 1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.
- C. Spray-Applied Cellulosic Insulation: Apply spray-applied insulation according to manufacturer's written instructions.
  - 1. Do not apply insulation until installation of pipes, ducts, conduits, wiring, and electrical outlets in walls is completed and windows, electrical boxes, and other items not indicated to receive insulation are masked.
  - 2. After insulation is applied, make flush with face of studs by using method recommended by insulation manufacturer.

### 3.6 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.
- B. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

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## SECTION 072500 - WEATHER BARRIERS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Building paper.
  - 2. Building wrap.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. For building wrap, include data on air and water-vapor permeance based on testing according to referenced standards.
- B. Shop Drawings: Show details of building wrap at terminations, openings, and penetrations. Show details of flexible flashing applications.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For water-resistive barrier, from ICC-ES.

### PART 2 PRODUCTS

#### 2.1 WATER-RESISTIVE BARRIER FOR ROOF APPLICATIONS

- A. Building Paper: Water-vapor-permeable, asphalt-saturated kraft building paper that complies with ICC-ES AC38, Grade D; except with water-resistance rating not less than 1 hour.

#### 2.2 WATER-RESISTIVE BARRIER FOR WALL AND OTHER APPLICATIONS

- A. Building Wrap: ASTM E1677, Type I air barrier; with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, when tested according to ASTM E84; UV stabilized; and acceptable to authorities having jurisdiction.

1. Basis-of-Design Product: Subject to compliance with requirements, provide TYPAR Building Wrap by TYPAR, a Berry Global Inc. Company; or a comparable product by one of the following:
  - a. Dorken Systems Inc.
  - b. The Dow Chemical Company.
  - c. DuPont Safety and Construction.
  - d. Kingspan Insulation Limited.
  - e. Ludlow Coated Products.
  - f. Raven Industries, Inc.
2. Water-Vapor Permeance: Not less than 8 perms per ASTM E96/E96M, Desiccant Method (Procedure A).
3. Air Permeance: Not more than 0.004 cfm/sq. ft. at 0.3-inch water gauge when tested according to ASTM E2178.
4. Allowable UV Exposure Time: Not less than three months.
5. Flame Propagation Test: Materials and construction shall be as tested according to NFPA 285.

### PART 3 EXECUTION

#### 3.1 WATER-RESISTIVE BARRIER INSTALLATION

- A. Cover exposed exterior surface of sheathing with water-resistive barrier securely fastened to framing immediately after sheathing is installed.
- B. Cover sheathing with water-resistive barrier as follows:
  1. Cut back barrier 1/2 inch on each side of the break in supporting members at expansion- or control-joint locations.
  2. Apply barrier to cover vertical flashing with a minimum 4-inch overlap unless otherwise indicated.
- C. Building Paper: Apply horizontally with a 2-inch overlap and a 6-inch end lap; fasten to sheathing with galvanized staples or roofing nails.
- D. Building Wrap: Comply with manufacturer's written instructions and warranty requirements.
  1. Seal seams, edges, fasteners, and penetrations with tape.
  2. Extend into jambs of openings and seal corners with tape.

### END OF SECTION

## SECTION 072600 - VAPOR RETARDERS

### 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. Sheet vapor retarders.

#### 1.3 ACTION SUBMITTALS

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

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: For each product, for tests performed by a qualified testing agency.

### PART 2 PRODUCTS

#### 2.1 SHEET VAPOR RETARDERS

- A. Sheet Vapor Retarders: ASTM D4397, with maximum permeance rating of 0.1 perm.
  - 1. Basis of Design Product: Subject to compliance with requirements, provide 15-mil Stego Wrap manufactured by Stego Industries, Inc., or a comparable product by one of the following:
    - a. Reef Industries, Inc.
    - b. Resisto, a Division of Soprema
    - c. W.R. Meadows North America

#### 2.2 ACCESSORIES

- A. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

- B. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.
- C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Clean substrates of substances that are harmful to vapor retarders, including removing projections capable of puncturing vapor retarders.

### 3.2 INSTALLATION OF VAPOR RETARDERS BELOW CONCRETE SLABS

- A. Install over an aggregate, sand, or tamped earth base. A cushion layer is not required.
- B. Unroll vapor retarder over the area where the slab is to be placed. Vapor retarder should completely cover the concrete placement area. All joints/ seams both lateral and butt should be overlapped a minimum of 6" and taped using vapor retarder tape.
  - 1. The area of adhesion should be free from dust, dirt, moisture, and frost to allow maximum adhesion of the pressure-sensitive tape.
- C. ASTM E1643 requires sealing the perimeter of the slab. Extend vapor retarder over footings and seal to foundation wall, grade beam, or slab at an elevation consistent with the top of the slab or terminate at impediments such as waterstops or dowels. Consult the structural engineer of record before proceeding.
  - 1. Seal to Slab at Perimeter:
    - a. Clean the surface of vapor retarder to ensure that the area of adhesion is free from dust, dirt, moisture, and frost to allow maximum adhesion of the pressure-sensitive adhesive.
    - b. Install vapor retarder tape on the entire perimeter edge of vapor retarder.
    - c. Prior to the placement of concrete, ensure that the top of vapor retarder tape is free of dirt, debris, or mud to maximize the bond to the concrete.
  - 2. Seal to Perimeter Wall with Vapor Retarder Tape:
    - a. Make sure area of adhesion is free of dust, dirt, debris, moisture, and frost to allow maximum adhesion.
    - b. Remove release liner on one side and stick to desired surface.
    - c. When ready to apply vapor retarder, remove the exposed release liner and press vapor retarder firmly against vapor retarder tape to secure.

### 3.3 PROTECTION



- A. Protect vapor retarders from damage until concealed by permanent construction.

END OF SECTION

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## SECTION 075323 - ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Adhered ethylene-propylene-diene-monomer (EPDM) roofing system.
  - 2. Mechanically fastened, ethylene-propylene-diene-monomer (EPDM) roofing system.
  - 3. Roof insulation, including tapered insulation.
- B. Related Requirements:
  - 1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
  - 2. Section 072100 "Thermal Insulation" for insulation beneath the roof deck.
  - 3. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counter-flashings.
  - 4. Section 077100 "Roof Specialties" for manufactured copings.
  - 5. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

#### 1.3 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D1079 and glossary of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Roofing Conference: Conduct conference at Project site.
  - 1. Meet with Owner, Architect, Construction Manager, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
  - 2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.

3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of roofing product specified. Include data substantiating that materials comply with requirements, are compatible as demonstrated by roofing system manufacturer testing and field experience and accepted by roofing system manufacturer as an approved manufacturer's system.
  1. For insulation and roof system component fasteners, include copy of FM Approvals' RoofNav listing.
- B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:
  1. Layout and thickness of insulation.
  2. Base flashings and membrane terminations.
  3. Flashing details at penetrations.
  4. Tapered insulation, thickness, slopes, and crickets.
  5. Roof plan showing orientation of steel roof deck and orientation of roof membrane and fastening spacings and patterns for mechanically fastened roofing system.
  6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
  7. Adhesive application patterns and spacings for adhesion to metal deck, insulation and membranes within 16-feet of roof perimeters and inside the 16-foot perimeter.
- C. Samples for Verification: For the following products:
  1. 12 inch by 12 inch square of sheet roofing, of color specified, including T-shaped side and end lap seam.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.

- B. Manufacturer Certificates:
    - 1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements".
      - a. Submit evidence of complying with performance requirements.
    - 2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.
  - C. Product Test Reports: For components of roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.
  - D. Evaluation Reports: For components of roofing system, from ICC-ES.
    - 1. Field Test Reports:
    - 2. Concrete internal relative humidity test reports.
    - 3. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.
  - E. Field quality-control reports.
  - F. Sample Warranties: For manufacturer's special warranties.
- 1.7 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For roofing system to include in maintenance manuals.
  - B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.
- 1.8 QUALITY ASSURANCE
- A. Manufacturer Qualifications: A qualified manufacturer that is UL listed or listed in FM Approvals' RoofNav for roofing system identical to that used for this Project.
  - B. Installer Qualifications: Engage an experienced installer to perform work of this Section who has specialized in installing roofing similar to that required for this Project and who is approved, authorized, certified or licensed by the roofing system manufacturer to install manufacturer's product.
  - C. Age of Materials: All materials shall be manufactured within 9 months of its scheduled installation in this Project, or sooner if so recommended by the manufacturer.

- D. Fire-Test-Response Characteristics: Provide roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method indicated below by UL, FM, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
  - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location, at least 8-inches above grade or 4-inches above roof level. Comply with insulation manufacturer's written instructions for handling, and storing during installation. Where material is stored subject to weather, completely cover tops and sides with plastic tarps at all times.
- D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

#### 1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.
  - 1. No roofing shall be done during inclement weather of any degree. Temperature shall be 40 deg. F and rising. Perform no roofing work unless roof deck and existing roofing insulation to remain are completely dry, free from any water, dew, frost, ice or snow. Follow manufacturer's instruction for storage, handling, and use of materials during cold weather.
- B. Where applicable, remove existing roofing materials, and prepare for reroofing, only that area that can be made watertight by installing new roof assembly by the end of the normal working day. It is not the intent of this paragraph that the Contractor work beyond the normal working day, except in case of emergency. Phased construction extending beyond one day shall not be permitted.

1. If, due to unforeseen circumstances, the work is delayed, the Contractor shall continue work until the entire area from which roofing was removed has been completely reroofed before leaving the site. Under no circumstances shall any roof area be left open at the end of the day's work.
  2. Roof shall be left in water-tight and moisture-tight, condition at end of each day's work, including roof edges and flashing as required,
  3. Take all reasonable precautions to ensure that Contractor is not caught during the working day by rain.
  4. Maintain on hand on the deck for emergency use suitable approved material sufficient to temporarily cover open areas of the roof.
  5. It is of prime importance to prevent water from entering the building due to conditions caused by these operations and is the responsibility of the Contractor to take precautions at all times during the progress of the work, at nights, over weekends and during periods when work may be delayed by inclement weather.
  6. Protect areas of existing and new roofing where new flashings are installed or sheet metal, mechanical, and other repair work will be required by using plywood or planks laid "flat" on the roof for protection.
  7. Protect completed roofs used to access other work areas. Provide plywood panel paths from work area to temporary access stairs, trash chutes and crane loading areas. Rope off access path with surface mounted posts, rope and ribbon flagging at 24-inches on center or plastic snow-fencing.
- C. Protection of Existing Building and Surrounding Features: As follows:
1. Protect existing roof surfaces to remain from dirt, job traffic and overloading of stored materials.
  2. Install closed chutes or other suitable approved protection from the roof to the ground, to prevent damage to the building where existing roofing is to be removed and discarded from the roof to the ground. Protect glazing and other building materials from damage or staining by using suitable coverings.
  3. Protect trees, lawn, shrubs, and other elements within staging area to prevent damage to existing elements.
  4. Provide fencing and barricades, as approved by the Architect, to seal off and protect staging areas over which material will be moved. Fencing must be of adequate type and height, securely installed and maintained to seal off areas from students and staff in order to prevent injury or damage. All protection and safety-related items shall be the responsibility of the Contractor.
  5. Cooperate with the Owner in order not to block off any roads, walks, exit doors or service areas. Observe Owner's rules and regulations and restrict access over routes shown on the Drawings. The main entry to the building must be kept open and usable.
  6. Cordon off adjacent existing roof, noted as NIC (Not In Contract).

7. At completion of project, remove all fences and other protection. Restore all roads, walks, lawns, shrubs, trees and any other site and building elements that were damaged during construction.

D. Coordination with Owner as follows:

1. At specific times during the day and on specific days, cease work that generates loud noise. The Owner's schedule of hours and days will be provided prior to the start of work. Quiet time shall include, but is not limited to, the following:
  - a. Weekday hours included in a written notice from the Owner and delivered to the Contractor a minimum of 21 days prior to Owner's event.
  - b. Weekend hours included in a written notice from the Owner and delivered to the Contractor a minimum of 21 days prior to Owner's event.
  - c. Loud noise includes, but is not limited to; roof material removal, use of trash chutes, placing or removing waste containers and backing up construction vehicles.
2. Submit construction schedule to Owner 21 days in advance of work start to provide Owner time to notify building inhabitants and implement safety procedures.

## 1.11 WARRANTY

- A. General Warranty: The warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
  1. Special warranty includes roof membrane, base flashings, roof insulation, fasteners, substrate board, and other components of roofing system.
  2. Warranty Period: 20 years from Date of Substantial Completion.
- C. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashing, roof insulation, fasteners, and substrate boards for the following warranty period:
  1. Warranty Period: Two years from Date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS



- A. General Performance: Installed roofing system and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and flashings shall remain watertight.
  - 1. Accelerated Weathering: Roof membrane shall withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
  - 2. Impact Resistance: Roof membrane shall resist impact damage when tested according to ASTM D3746, ASTM D4272, or the Resistance to Foot Traffic Test in FM Approvals 4470.
- B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.
- C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897:
  - 1. Zone 1 (Roof Area Field): 20 lbf/sq. ft. 0.95 kPa/sq. m).
  - 2. Zone 2 (Roof Area Perimeter): 30 lbf/sq. ft. (1.42 kPa/sq. m).
  - 3. Zone 3 (Roof Area Corners): 30 lbf/sq. ft. (1.42kPa/sq. m).
- D. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials shall comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and shall be listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.
  - 1. Fire/Windstorm Classification: Class 1A-90.
- E. Exterior Fire-Test Exposure: ASTM E108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- F. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

## 2.2 MATERIAL AND EQUIPMENT

- A. Use approved type of equipment for removal of ballast and roofing that will not damage or destroy the roofing elements to remain, nor adjacent roofs not in Contract.
- B. Approved hoists, cranes, chutes, and other mechanical listing equipment shall be of the size and placed to avoid any physical contact with the building walls or structure. Chutes, if approved, shall not allow the spread of dust or debris. Submit plans for approval.

## 2.3 MANUFACTURERS, GENERAL

- A. Source Limitations: Obtain components for roofing system from roof membrane manufacturer or manufacturer approved by roof membrane manufacturer.

## 2.4 ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

- A. EPDM Sheet: Uniform, flexible sheet formed from a monomer of ethylene-propylene-diene, complying with ASTM D 4637, Type 1, of the following grade, class, thickness, and exposed face color:
  - a. Grade and Class: Grade 1 and Class U, non-reinforced.
  - b. Thickness: 60 mils (1.5 mm), nominal.
  - c. Color: Black.
  - d. Fire retardant, Class A material.
- B. Basis of Design Product: Subject to compliance with requirements, provide RubberGard MAX EPDM Roofing (60 mil) by Firestone Building Products, or a comparable product by one of the following:
  - a. Carlisle SynTec Incorporated.
  - b. Johns Manville; a Berkshire Hathaway company.
  - c. Versico Roofing Systems

## 2.5 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
  - 1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: 60 mil thick EPDM, partially cured or cured, according to application.
- C. Slip Sheet: Manufacturer's standard, of thickness required for application.
- D. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- E. Roof Vents: As recommended by roof membrane manufacturer.
  - 1. Size: Not less than 4-inch diameter.
- F. Bonding Adhesive: Manufacturer's standard.
- G. Splice Adhesive and Cleaner: Single-component butyl splicing adhesive and solvent-based splice cleaner.
- H. Splice Primer and Tape: Manufacturer's standard synthetic rubber polymer primer. 3 inch wide minimum butyl splice tape with release film at all membrane splices; and 3 inch wide minimum butyl splice tape with release film elsewhere.
- I. Seam Cove Tape: 6-inch wide, minimum, pressure sensitive flashing.
- J. Lap Sealant: Manufacturer's standard single-component sealant.

- K. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.
- L. Metal Termination Bars: Manufacturer's standard, predrilled aluminum bars, approximately 1 inch wide, roll formed and prepunched, with ledge for sealant.
- M. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening components to substrate, and acceptable to roofing system manufacturer.
- N. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, molded pipe boot flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.
- O. Wood Fiber Materials: Use of any wood fiber materials is prohibited.
- P. Insulation and Steel Deck Adhesive: Manufacturer's standard VOC compliant, low-rise foam.

## 2.6 ROOF INSULATION

- A. General: Roof insulation selected shall be compatible to the roof membrane and insulation to remain. The insulating value of the total roof system shall be a minimum R of 30. R values for insulation calculations shall be industry-accepted standards for "aged" insulation. For polyisocyanurate, use R +5.7 per inch of thickness or manufacturer's tested aged values. Roof insulation, both flat and tapered under an adhered membrane, shall have a minimum of 25 psi compressive strength, as certified in writing by the manufacturer and affixed to shipping manifest.
  - 1. Provide preformed, tapered insulation boards where indicated for sloping to drain. Fabricate with taper as indicated on Drawings.
    - a. Polyisocyanurate: Minimum 0.5 inch at bottom edge of taper.
  - 2. Provide preformed saddles, crickets, tapered edge strips and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated. Field tapering of insulation shall not be permitted.
    - a. Provide polyisocyanurate insulation saddle panels 0.25 inch per foot taper.
  - 3. Use of wood fiber materials is prohibited.
- B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 2 felt or glass-fiber mat facer on both major surfaces.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Carlisle SynTec Incorporated.
    - b. Firestone Building Products.
    - c. Johns Manville; a Berkshire Hathaway company.
    - d. NRG Barriers, Inc.

- e. Versico Roofing Systems
- 2. Compressive Strength: 25 psi.
- 3. Size: Maximum 48 inches by 48 inches.
- 4. Thickness: Board thickness shall be 2 1/2 inches maximum at non-tapered and tapered panel locations indicated

## 2.7 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation to substrate, and acceptable to roofing system manufacturer.
- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
  - 1. Modified asphaltic, asbestos-free, cold-applied adhesive.
  - 2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
  - 3. Full-spread, spray-applied, low-rise, two-component urethane adhesive.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
  - 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
  - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
  - 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

- C. Perform fastener-pullout tests according to roof system manufacturer's written instructions.
  - 1. Submit test result within 24 hours of performing tests.
    - a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.
- D. Install sound-absorbing insulation strips according to acoustical roof deck manufacturer's written instructions.

### 3.3 INSTALLATION OF ROOFING, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions, FM Approvals' RoofNav assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
- C. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition and to not void warranty for existing roofing system.

### 3.4 INSTALLATION OF INSULATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Installation Over Metal Decking:
  - 1. Install base layer of insulation with joints staggered not less than 24 inches in adjacent rows, end joints staggered not less than 12 inches in adjacent rows, and with long joints continuous at right angle to flutes of decking.
    - a. Locate end joints over crests of decking.
    - b. Where installing composite and non-composite insulation in two or more layers, install non-composite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
    - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
    - d. Make joints between adjacent insulation boards not more than 1/4 inch width.

- e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
    - 1) Trim insulation so that water flow is unrestricted.
  - f. Fill gaps exceeding 1/4 inch with insulation.
  - g. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
  - h. Loosely lay each layer of insulation units over substrate.
  - i. Where mechanically attach base layer of insulation and substrate board using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
    - 1) Fasten insulation according to requirements in FM Approvals' RoofNav for specified Windstorm Resistance Classification.
    - 2) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.
- a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
  - b. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
  - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
  - d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
  - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
  - f. Trim insulation so that water flow is unrestricted.
  - g. Fill gaps exceeding 1/4 inch with insulation.
  - h. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
  - i. Loosely lay each layer of insulation units over substrate.
  - j. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
    - 1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.
    - 2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
    - 3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

### 3.5 INSTALLATION OF ADHERED ROOF MEMBRANE

- A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
- B. Unroll membrane roof membrane and allow to relax before installing.
- C. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
- D. Accurately align roof membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- E. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.
- F. Apply roof membrane with side laps shingled with slope of roof deck where possible.
- G. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement.
  - 1. Firmly roll side and end laps of overlapping roof membrane to ensure a watertight seam installation.
  - 2. Apply lap sealant and seal exposed edges of roofing terminations.
  - 3. Apply a continuous bead of in-seam sealant before closing splice if required by roofing system manufacturer.
- H. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape.
  - 1. Firmly roll side and end laps of overlapping roof membrane to ensure a watertight seam installation.
  - 2. Apply lap sealant and seal exposed edges of roofing terminations.
- I. Factory-Applied Seam Tape Installation: Clean and prime surface to receive tape.
  - 1. Firmly roll side and end laps of overlapping roof membrane to ensure a watertight seam installation.
  - 2. Apply lap sealant and seal exposed edges of roofing terminations.
- J. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.
- K. Spread sealant or mastic bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.
- L. Adhere protection sheet over roof membrane at locations indicated.

### 3.6 INSTALLATION OF BASE FLASHING

- A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

### 3.7 FIELD QUALITY CONTROL

- A. Manufacturer's Roofing Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation periodically and on completion and submit reports of same to Architect.
  - 1. Notify Architect 48 hours in advance of the dates and times of inspections.
- B. Demonstrate adhesion of the membrane to the insulation below by applying the minimum recommended uplift force for 5 seconds to an area selected at random by the Architect. An optional method of verifying membrane adhesion is to have the manufacturer's technical representative forcefully drag the bottom of their foot across a 12-inch path on the membrane, with any portion becoming unadhered or bubbling up considered a failure.
  - 1. Provide scale, devices, temporary adhesive, etc. as required.
  - 2. If those areas fail, the entire area shall be classified as failed.
  - 3. All membrane areas which fail shall be re-adhered as recommended by the manufacturer.
- C. Testing Agency: Owner will engage a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, sheet flashings, protection, and drainage components, and to furnish reports to Architect.
- D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.
- E. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.



- F. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

### 3.8 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

### 3.9 ROOFING INSTALLER'S WARRANTY

- A. WHEREAS \_\_\_\_\_ of \_\_\_\_\_, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:
  - 1. Owner: Valley Central School District
  - 2. Address: 944 State Route 17K, Montgomery, NY 12549
  - 3. Building Name/Type: School Name Varies
  - 4. Address: Address/Location Varies
  - 5. Area of Work: See Drawings
  - 6. Acceptance Date: TBD
  - 7. Warranty Period: As Specified
  - 8. Expiration Date: As Specified
- B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.
- D. This Warranty is made subject to the following terms and conditions:
  - 1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

- a. lightning;
  - b. peak gust wind speed exceeding 100 mph;
  - c. fire;
  - d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
  - e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
  - f. vapor condensation on bottom of roofing; and
  - g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.

7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this \_\_\_\_\_ day of

\_\_\_\_\_, \_\_\_\_\_.

1. Authorized Signature: \_\_\_\_\_.
2. Name: \_\_\_\_\_.
3. Title: \_\_\_\_\_.

END OF SECTION

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## SECTION 077200 - ROOF ACCESSORIES

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Roof curbs.

#### 1.3 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof accessories.
  - 1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant and field assembled work.
- C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
  - 1. Size and location of roof accessories specified in this Section.
  - 2. Method of attaching roof accessories to roof or building structure.

3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

B. Sample Warranties: For manufacturer's special warranties.

## 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

## PART 2 PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

### 2.2 ROOF CURBS

- A. Roof Curbs: Internally reinforced roof-curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck-mounting flange at perimeter bottom.
1. Basis of Design Product: Subject to compliance with requirements, provide Roof Curb Systems Standard Fan Curb or comparable product by one of the following:
    - a. Conn-Fab Sales, Inc.
    - b. LM Curbs.
    - c. Roof Products, Inc.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Material: Zinc-coated (galvanized) steel sheet, 0.052 inch (1.32 mm) thick.
1. Finish: Mill phosphatized.
- D. Construction:
1. Curb Profile: Manufacturer's standard compatible with roofing system.
  2. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
  3. Fabricate curbs to minimum height of 24 inches (305 mm) above roofing surface unless otherwise indicated.

4. Top Surface: Level top of curb, with roof slope accommodated by sloping deck-mounting flange or by use of leveler frame.
5. Sloping Roofs: Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
6. Insulation: Factory insulated with 1-1/2-inch- (38-mm-) thick glass-fiber board insulation.
7. Liner: Same material as curb, of manufacturer's standard thickness and finish.
8. Nailer: Factory-installed wood nailer along top flange of curb, continuous around curb perimeter.
9. Wind Restraint Straps and Base Flange Attachment: Provide wind restraint straps, welded strap connectors, and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
10. Platform Cap: Where portion of roof curb is not covered by equipment, provide weathertight platform cap formed from 3/4-inch (19-mm) thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
11. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as curb.

## 2.3 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.
  1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
  2. Factory Prime Coating: Where field painting is indicated, apply pretreatment and white or light-colored, factory-applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil (0.005 mm.)
  3. Exposed Coil-Coated Finish: Pre-painted by the coil-coating process to comply with ASTM A 755/A 755M. Prepare, pre-treat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - a. Two-Coat Fluoropolymer Finish: AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
  4. Concealed Finish: Pre-treat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil (0.013 mm.)

## 2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.

- B. Glass-Fiber Board Insulation: ASTM C 726, nominal density of 3 lb/cu. ft. (48 kg/cu. m), thermal resistivity of 4.3 deg F x h x sq. ft./Btu x in. at 75 deg F (29.8 K x m/W at 24 deg C), thickness as indicated.
- C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches (38 mm) thick.
- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- E. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- F. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
- G. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

## 2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION



- A. General: Install roof accessories according to manufacturer's written instructions.
    - 1. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
    - 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
    - 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
    - 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
  - B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
    - 1. Coat concealed side of uncoated aluminum and stainless-steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
    - 2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with manufacturer's recommended slip sheet.
    - 3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
  - C. Roof Curb Installation: Install each roof curb so top surface is level.
  - D. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.
  - E. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.
- 3.3 REPAIR AND CLEANING
- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780/A 780M.
  - B. Touch up factory-primed surfaces with compatible primer ready for field painting, coordinate primer with architect.
  - C. Clean exposed surfaces according to manufacturer's written instructions.
  - D. Clean off excess sealants.
  - E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION

## SECTION 078413 - PENETRATION FIRESTOPPING

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Penetrations in fire-resistance-rated walls.
  - 2. Penetrations in horizontal assemblies.
  - 3. Penetrations in smoke barriers.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Schedule: For each penetration firestopping system. Include location and design designation of each type of firestopping system.
  - 1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping condition, submit illustration, with modifications marked, approved by penetration firestopping manufacturer's fire-protection engineer as an engineering judgment or equivalent fire-resistance-rated assembly.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Installer Certificates: From Installer indicating penetration firestopping has been installed in compliance with requirements and manufacturer's written recommendations.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for penetration firestopping.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing penetration firestopping similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its penetration firestopping products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
- B. Fire-Test-Response Characteristics: Penetration firestopping shall comply with the following requirements:
  - 1. Penetration firestopping tests are performed by a qualified testing agency acceptable to authorities having jurisdiction.
  - 2. Penetration firestopping is identical to those tested per testing standard referenced in "Penetration Firestopping" Article. Provide rated systems complying with the following requirements:
    - a. Penetration firestopping products bear classification marking of qualified testing and inspecting agency.
    - b. Classification markings on penetration firestopping correspond to designations listed by the following:
      - 1) UL in its "Fire Resistance Directory."
      - 2) Intertek ETL SEMKO in its "Directory of Listed Building Products."
- C. Pre-installation Conference: Conduct conference at Project site.

## 1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping when ambient or substrate temperatures are outside limits permitted by penetration firestopping manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

## 1.7 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping is installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping.

## 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. Grace Construction Products.
  2. Hilti, Inc.
  3. Johns Manville.
  4. Nelson Firestop Products.
  5. Specified Technologies Inc.
  6. 3M Fire Protection Products.
  7. Tremco, Inc.; Tremco Fire Protection Systems Group.
  8. USG Corporation.

## 2.2 PENETRATION FIRESTOPPING

- A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01 inch wg (2.49 Pa).
1. Fire-resistance-rated walls include fire walls fire-barrier walls smoke-barrier walls and fire partitions.
  2. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Provide penetration firestopping with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01 inch wg (2.49 Pa).
1. Horizontal assemblies include floors and floor/ceiling assemblies.
  2. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
  3. T-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
- D. Penetrations in Smoke Barriers: Provide penetration firestopping with ratings determined per UL 1479.
1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at 0.30 inch wg (74.7 Pa) at both ambient and elevated temperatures.

- E. W-Rating: Provide penetration firestopping showing no evidence of water leakage when tested according to UL 1479.
- F. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- G. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
  - 1. Sealants: 250 g/L.
  - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
  - 3. Sealant Primers for Porous Substrates: 775 g/L.
- H. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.
  - 1. Permanent forming/damming/backing materials, including the following:
    - a. Slag-wool-fiber or rock-wool-fiber insulation.
    - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
    - c. Fire-rated form board.
    - d. Fillers for sealants.
  - 2. Temporary forming materials.
  - 3. Substrate primers.
  - 4. Collars.
  - 5. Steel sleeves.

## 2.3 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized-steel sheet.

- E. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
  - 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces, and nonsag formulation for openings in vertical and sloped surfaces, unless indicated firestopping limits use of nonsag grade for both opening conditions.

## 2.4 MIXING

- A. For those products requiring mixing before application, comply with penetration firestopping manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

## PART 3 EXECUTION

### 3.1 EXAMINATION

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

### 3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing penetration firestopping to comply with manufacturer's written instructions and with the following requirements:
  - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping.
  - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping. Remove loose particles remaining from cleaning operation.
  - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping seal with substrates.

### 3.3 INSTALLATION

- A. General: Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
  - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.
- C. Install fill materials for firestopping by proven techniques to produce the following results:
  - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
  - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

### 3.4 IDENTIFICATION



- A. Identify penetration firestopping with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of firestopping edge so labels will be visible to anyone seeking to remove penetrating items or firestopping. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
  - 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
  - 2. Contractor's name, address, and phone number.
  - 3. Designation of applicable testing and inspecting agency.
  - 4. Date of installation.
  - 5. Manufacturer's name.
  - 6. Installer's name.

### 3.5 FIELD QUALITY CONTROL

- A. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements.
- B. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

### 3.6 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping is without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping and install new materials to produce systems complying with specified requirements.

### 3.7 PENETRATION FIRESTOPPING SCHEDULE

- A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.
- B. Firestopping with No Penetrating Items FS-1.1 (1hr rated penetration):
  - 1. UL-Classified Systems:
    - a. C-AJ-(0001-0999) or F-A-(0001-0999): Concrete Floors 5" thick and less.
    - b. C-BJ-(0001-0999) or F-B-(0001-0999): Concrete Floors thicker than 5".

- c. F-C-(0001-0999): Framed Floors.
    - d. C-AJ-(0001-0999) C-BJ-(0001-0999), or W-J-(0001-0999): Concrete/Masonry walls 8" thick or less.
    - e. W-L-(0001-0999): Framed Walls.
  2. F-Rating: 1 hour.
  3. T-Rating: 1 hour.
  4. L-Rating at Ambient: Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. W-Rating: No leakage of water at completion of water leakage testing.
  7. Type of Fill Materials: As required to achieve rating.
- C. Firestopping for Metallic Pipes, Conduit, or Tubing FS-2.1 (1hr rated penetration):
  1. UL-Classified Systems:
    - a. C-AJ-(1001-1999) or F-A-(1001-1999): Concrete Floors 5" thick and less.
    - b. C-BJ-(1001-1999), C-BK-(1001-1999), or F-B-(1001-1999): Concrete Floors thicker than 5".
    - c. F-C-(1001-1999): Framed Floors.
    - d. C-AJ-(1001-1999), C-BJ-(1001-1999) or W-J (1001-1999): Concrete/Masonry walls 8" thick or less.
    - e. C-BK-(1001-1999) or W-K-(1001-1999): Concrete/Masonry walls thicker than 8".
    - f. W-L-(1001-1999): Framed Walls.
  2. F-Rating: 1 hour.
  3. T-Rating: 1 hour.
  4. L-Rating at Ambient: Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. W-Rating: No leakage of water at completion of water leakage testing.
  7. Type of Fill Materials: As required to achieve rating.
- D. Firestopping for Nonmetallic Pipe, Conduit, or Tubing FS-3.1 (1hr rated penetration):
  1. UL-Classified Systems:
    - a. C-AJ-(2001-2999) or F-A (2001-2999): Concrete Floors 5" thick and less.
    - b. C-BJ-(2001-2999), C-BK (2001-2999) or F-B (2001-2999): Concrete Floors thicker than 5".
    - c. F-C (2001-2999): Framed Floors.
    - d. C-AJ (2001-2999), C-BJ (2001-1999) or W-J (2001-2999): Concrete/Masonry walls 8" thick or less.
    - e. C-BK (2001-2999) or W-K (2001-2999): Concrete/Masonry walls thicker than 8".
    - f. W-L (2001-2999): Framed Walls.
  2. F-Rating: 1 hour.
  3. T-Rating: 1 hour.
  4. L-Rating at Ambient: Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).

5. L-Rating at 400 deg F (204 deg C): Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. W-Rating: No leakage of water at completion of water leakage testing.
  7. Type of Fill Materials: As required to achieve rating.
- E. Firestopping for Electrical Cables FS-4.1 (1hr rated penetration):
1. UL-Classified Systems:
    - a. C-AJ-(3001-3999) or F-A-(3001-3999): Concrete Floors 5" thick and less.
    - b. C-BJ-(3001-3999), C-BK-(3001-3999) or F-B-(3001-3999): Concrete Floors thicker than 5".
    - c. F-C-(3001-3999): Framed Floors.
    - d. C-AJ-(3001-3999) C-BJ-(3001-3999) or W-J-(3001-3999): Concrete/Masonry walls 8" thick or less.
    - e. C-BK-(3001-3999) or W-K-(3001-3999): Concrete/Masonry walls thicker than 8".
    - f. W-L-(3001-2999): Framed Walls.
  2. F-Rating: 1 hour.
  3. T-Rating: 1 hour.
  4. L-Rating at Ambient: Less than 4.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. W-Rating: No leakage of water at completion of water leakage testing.
  7. Type of Fill Materials: As required to achieve rating.
- F. Firestopping for Cable Trays with Electric Cables FS-5.1 (1hr rated penetration):
1. UL-Classified Systems:
    - a. C-AJ-(4001-4999) or F-A-(4001-4999): Concrete Floors 5" thick and less.
    - b. C-BJ-(4001-4999), C-BK-(4001-4999) or F-B-(4001-4999): Concrete Floors thicker than 5".
    - c. C-AJ-(4001-4999) C-BJ-(4001-4999) or W-J-(4001-4999): Concrete/Masonry walls 8" thick or less.
    - d. C-BK-(4001-4999) or W-K-(4001-4999): Concrete/Masonry walls thicker than 8".
    - e. W-L-(4001-4999): Framed Walls.
  2. F-Rating: 1 hour.
  3. T-Rating: 1 hour.
  4. L-Rating at Ambient: Less than 5.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 2.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. Type of Fill Materials: As required to achieve rating.
- G. Firestopping for Insulated Pipes FS-6.1 (1hr rated penetration):
1. UL-Classified Systems:
    - a. C-AJ-(5001-5999) or F-A-(5001-5999): Concrete Floors 5" thick and less.
    - b. C-BJ-(5001-5999) C-BK-(5001-5999) or F-B-(5001-5999): Concrete Floors thicker than 5".

- c. F-C-(5001-5999): Framed Floors.
    - d. C-AJ-(5001-5999) C-BJ-(5001-5999) or W-J-(5001-5999): Concrete/Masonry walls 8" thick or less.
    - e. C-BK-(5001-5999): Concrete/Masonry walls thicker than 8".
    - f. W-L-(5001-5999): Framed Walls.
  2. F-Rating: 1 hour.
  3. T-Rating: 1 hour.
  4. L-Rating at Ambient: Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. W-Rating: No leakage of water at completion of water leakage testing.
  7. Type of Fill Materials: As required to achieve rating.
- H. Firestopping for Miscellaneous Electrical Penetrants FS-7.1 (1hr rated penetration):
1. UL-Classified Systems:
    - a. C-AJ-(6001-6999) or F-A-(6001-6999): Concrete Floors 5" thick and less.
    - b. C-BJ-(6001-6999): Concrete Floors thicker than 5".
    - c. C-AJ-(6001-6999) C-BJ-(6001-6999) or W-J-(6001-6999): Concrete/Masonry walls 8" thick or less.
    - d. W-L-(6001-6999): Framed Walls.
  2. F-Rating: 1 hour.
  3. T-Rating: 1 hour.
  4. L-Rating at Ambient: Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. W-Rating: No leakage of water at completion of water leakage testing.
  7. Type of Fill Materials: As required to achieve rating.
- I. Firestopping for Miscellaneous Mechanical Penetrants FS-8.1 (1hr rated penetration):
1. UL-Classified Systems:
    - a. C-AJ-(7001-7999) or F-A-(7001-7999): Concrete Floors 5" thick and less.
    - b. C-BJ-(7001-7999) or F-B-(7001-7999): Concrete Floors thicker than 5".
    - c. F-C-(7001-7999): Framed Floors.
    - d. C-AJ-(7001-7999) C-BJ-(7001-7999) or W-J-(7001-7999): Concrete/Masonry walls 8" thick or less.
    - e. W-L-(7001-7999): Framed Walls.
  2. F-Rating: 1 hour.
  3. T-Rating: 1 hour.
  4. L-Rating at Ambient: Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. W-Rating: No leakage of water at completion of water leakage testing.
  7. Type of Fill Materials: As required to achieve rating.
- J. Firestopping for Groupings of Penetrants FS-9.1 (1hr rated penetration):
1. UL-Classified Systems:

- a. C-AJ-(8001-8999) or F-A-(8001-8999): Concrete Floors 5" thick and less.
    - b. C-BJ-(8001-8999) or F-B-(8001-8999): Concrete Floors thicker than 5".
    - c. F-C-(8001-8999): Framed Floors.
    - d. C-AJ-(8001-8999) C-BJ-(8001-8999) or W-J-(8001-8999): Concrete/Masonry walls 8" thick or less.
    - e. W-L-(8001-8999): Framed Walls.
  2. F-Rating: 1 hour.
  3. T-Rating: 1 hour.
  4. L-Rating at Ambient: Less than 14.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 14.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. W-Rating: No leakage of water at completion of water leakage testing.
  7. Type of Fill Materials: As required to achieve rating.
- K. Firestopping with No Penetrating Items FS-1.2 (2hr rated penetration):
1. UL-Classified Systems:
    - a. C-AJ-(0001-0999) or F-A-(0001-0999): Concrete Floors 5" thick and less.
    - b. C-BJ-(0001-0999) or F-B-(0001-0999): Concrete Floors thicker than 5".
    - c. F-C-(0001-0999): Framed Floors.
    - d. C-AJ-(0001-0999) C-BJ-(0001-0999) or W-J-(0001-0999): Concrete/Masonry walls 8" thick or less.
    - e. W-L-(0001-0999): Framed Walls.
  2. F-Rating: 2 hour.
  3. T-Rating: 2 hour.
  4. L-Rating at Ambient: Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. W-Rating: No leakage of water at completion of water leakage testing.
  7. Type of Fill Materials: As required to achieve rating.
- L. Firestopping for Metallic Pipes, Conduit, or Tubing FS-2.2 (2hr rated penetration):
1. UL-Classified Systems:
    - a. C-AJ-(1001-1999) or F-A-(1001-1999): Concrete Floors 5" thick and less.
    - b. C-BJ-(1001-1999), C-BK-(1001-1999), or F-B-(1001-1999): Concrete Floors thicker than 5".
    - c. F-C-(1001-1999): Framed Floors.
    - d. C-AJ-(1001-1999), C-BJ-(1001-1999) or W-J (1001-1999): Concrete/Masonry walls 8" thick or less.
    - e. C-BK-(1001-1999) or W-K-(1001-1999): Concrete/Masonry walls thicker than 8".
    - f. W-L-(1001-1999): Framed Walls.
  2. F-Rating: 2 hour.
  3. T-Rating: 2 hour.
  4. L-Rating at Ambient: Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).

6. W-Rating: No leakage of water at completion of water leakage testing.
  7. Type of Fill Materials: As required to achieve rating.
- M. Firestopping for Nonmetallic Pipe, Conduit, or Tubing FS-3.2 (2hr rated penetration):
1. UL-Classified Systems:
    - a. C-AJ-(2001-2999) or F-A (2001-2999): Concrete Floors 5" thick and less.
    - b. C-BJ-(2001-2999), C-BK (2001-2999) or F-B (2001-2999): Concrete Floors thicker than 5".
    - c. F-C (2001-2999): Framed Floors.
    - d. C-AJ (2001-2999), C-BJ (2001-1999) or W-J (2001-2999): Concrete/Masonry walls 8" thick or less.
    - e. C-BK (2001-2999) or W-K (2001-2999): Concrete/Masonry walls thicker than 8".
    - f. W-L (2001-2999): Framed Walls.
  2. F-Rating: 2 hour.
  3. T-Rating: 2 hour.
  4. L-Rating at Ambient: Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. W-Rating: No leakage of water at completion of water leakage testing.
  7. Type of Fill Materials: As required to achieve rating.
- N. Firestopping for Electrical Cables FS-4.2 (2hr rated penetration):
1. UL-Classified Systems:
    - a. C-AJ-(3001-3999) or F-A-(3001-3999): Concrete Floors 5" thick and less.
    - b. C-BJ-(3001-3999) C-BK-(3001-3999) or F-B-(3001-3999): Concrete Floors thicker than 5".
    - c. F-C-(3001-3999): Framed Floors.
    - d. C-AJ-(3001-3999) C-BJ-(3001-3999) or W-J-(3001-3999): Concrete/Masonry walls 8" thick or less.
    - e. C-BK-(3001-3999) or W-K-(3001-3999): Concrete/Masonry walls thicker than 8".
    - f. W-L-(3001-2999): Framed Walls.
  2. F-Rating: 2 hour.
  3. T-Rating: 2 hour.
  4. L-Rating at Ambient: Less than 4.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. W-Rating: No leakage of water at completion of water leakage testing.
  7. Type of Fill Materials: As required to achieve rating.
- O. Firestopping for Cable Trays with Electric Cables FS-5.2 (2hr rated penetration):
1. UL-Classified Systems:
    - a. C-AJ-(4001-4999) or F-A-(4001-4999): Concrete Floors 5" thick and less.

- b. C-BJ-(4001-4999), C-BK-(4001-4999) or F-B-(4001-4999): Concrete Floors thicker than 5".
    - c. C-AJ-(4001-4999) C-BJ-(4001-4999) or W-J-(4001-4999): Concrete/Masonry walls 8" thick or less.
    - d. C-BK-(4001-4999) or W-K-(4001-4999): Concrete/Masonry walls thicker than 8".
    - e. W-L-(4001-4999): Framed Walls.
  2. F-Rating: 2 hour.
  3. T-Rating: 2 hour.
  4. L-Rating at Ambient: Less than 5.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 2.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. Type of Fill Materials: As required to achieve rating.
- P. Firestopping for Insulated Pipes FS-6.2 (2hr rated penetration):
  1. UL-Classified Systems:
    - a. C-AJ-(5001-5999) or F-A-(5001-5999): Concrete Floors 5" thick and less.
    - b. C-BJ-(5001-5999) C-BK-(5001-5999) or F-B-(5001-5999): Concrete Floors thicker than 5".
    - c. F-C-(5001-5999): Framed Floors.
    - d. C-AJ-(5001-5999) C-BJ-(5001-5999) or W-J-(5001-5999): Concrete/Masonry walls 8" thick or less.
    - e. C-BK-(5001-5999): Concrete/Masonry walls thicker than 8".
    - f. W-L-(5001-5999): Framed Walls.
  2. F-Rating: 2 hour.
  3. T-Rating: 2 hour.
  4. L-Rating at Ambient: Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. W-Rating: No leakage of water at completion of water leakage testing.
  7. Type of Fill Materials: As required to achieve rating.
- Q. Firestopping for Miscellaneous Electrical Penetrants FS-7.2 (2hr rated penetration):
  1. UL-Classified Systems:
    - a. C-AJ-(6001-6999) or F-A-(6001-6999): Concrete Floors 5" thick and less.
    - b. C-BJ-(6001-6999) Concrete Floors thicker than 5".
    - c. C-AJ-(6001-6999) C-BJ-(6001-6999) or W-J-(6001-6999): Concrete/Masonry walls 8" thick or less.
    - d. W-L-(6001-6999): Framed Walls.
  2. F-Rating: 2 hour.
  3. T-Rating: 2 hour.
  4. L-Rating at Ambient: Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. W-Rating: No leakage of water at completion of water leakage testing.
  7. Type of Fill Materials: As required to achieve rating.

- R. Firestopping for Miscellaneous Mechanical Penetrants FS-8.2 (2hr rated penetration):
1. UL-Classified Systems:
    - a. C-AJ-(7001-7999) or F-A-(7001-7999): Concrete Floors 5" thick and less.
    - b. C-BJ-(7001-7999) or F-B-(7001-7999): Concrete Floors thicker than 5".
    - c. F-C-(7001-7999): Framed Floors.
    - d. C-AJ-(7001-7999) C-BJ-(7001-7999) or W-J-(7001-7999): Concrete/Masonry walls 8" thick or less.
    - e. W-L-(7001-7999): Framed Walls.
  2. F-Rating: 2 hour.
  3. T-Rating: 2 hour.
  4. L-Rating at Ambient: Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 1.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. W-Rating: No leakage of water at completion of water leakage testing.
  7. Type of Fill Materials: As required to achieve rating.
- S. Firestopping for Groupings of Penetrants FS-9.2 (2hr rated penetration):
1. UL-Classified Systems:
    - a. C-AJ-(8001-8999) or F-A-(8001-8999): Concrete Floors 5" thick and less.
    - b. C-BJ-(8001-8999) or F-B-(8001-8999): Concrete Floors thicker than 5".
    - c. F-C-(8001-8999): Framed Floors.
    - d. C-AJ-(8001-8999) C-BJ-(8001-8999) or W-J-(8001-8999): Concrete/Masonry walls 8" thick or less.
    - e. W-L-(8001-8999): Framed Walls.
  2. F-Rating: 2 hour.
  3. T-Rating: 2 hour.
  4. L-Rating at Ambient: Less than 14.0 cfm/sq. ft. (cu. m/s per sq. m).
  5. L-Rating at 400 deg F (204 deg C): Less than 14.0 cfm/sq. ft. (cu. m/s per sq. m).
  6. W-Rating: No leakage of water at completion of water leakage testing.
  7. Type of Fill Materials: As required to achieve rating.

END OF SECTION



## SECTION 078446 - FIRE-RESISTIVE JOINT SYSTEMS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes fire-resistive joint systems for the following:
  - 1. Floor-to-floor joints.
  - 2. Floor-to-wall joints.
  - 3. Head-of-wall joints.
  - 4. Wall-to-wall joints.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. General: For joints in the following constructions, provide fire-resistive joint systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly in which fire-resistive joint systems are installed:
  - 1. Fire-resistance-rated load-bearing walls, including partitions, with fire-protection-rated openings.
  - 2. Fire-resistance-rated non-load-bearing walls, including partitions, with fire-protection-rated openings.
  - 3. Fire-resistance-rated floor assemblies.
  - 4. Exterior curtain-wall assemblies and fire-resistance-rated floor assemblies.
- B. Fire Resistance of Joint Systems: Assembly ratings and movement capabilities indicated, but with assembly ratings not less than that equaling or exceeding fire-resistance rating of constructions in which joints are located, as determined by UL 2079.
- C. Fire Resistance of Perimeter Fire-Containment Systems: Integrity and insulation ratings indicated as determined by UBC Standard 26-9 and UL 2079.

#### 1.4 SUBMITTALS

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

- B. Shop Drawings: For each fire-resistive joint system, show each kind of construction condition in which joints are installed and relationships to adjoining construction. Include fire-resistive joint system design designation of testing and inspecting agency acceptable to authorities having jurisdiction that demonstrates compliance with requirements for each condition indicated.
  - 1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each fire-resistive joint system configuration for construction and penetrating items.
- C. Product Certificates: For each type of fire-resistive joint system, signed by product manufacturer.
- D. Qualification Data: For Installer.
- E. Evaluation Reports: Evidence of fire-resistive joint systems' compliance with ICBO ES AC308, from the ICBO Evaluation Service.

#### 1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain fire-resistive joint systems for each kind of joint and construction condition indicated through one source from a single manufacturer.
- B. Fire-Test-Response Characteristics: Provide fire-resistive joint systems that comply with the following requirements and those specified in "Performance Requirements" Article:
  - 1. Fire-resistance tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL or another agency performing testing and follow-up inspection services for fire-resistive joint systems acceptable to authorities having jurisdiction.
  - 2. Fire-resistive joint systems are identical to those tested per UL 2079. Perimeter fire-containment systems are identical to those tested per both UBC Standard 26-9 and UL 2079. Provide rated systems complying with the following requirements:
    - a. Fire-resistive joint systems correspond to those indicated by referencing system designations listed by the following:
      - 1) UL in its "Fire Resistance Directory."

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver fire-resistive joint system products to Project site in original, unopened containers or packages with qualified testing and inspecting agency's classification marking applicable to Project and with intact and legible manufacturers' labels identifying product and manufacturer, date of manufacture, lot number, shelf life, curing time, and mixing instructions for multicomponent materials.

- B. Store and handle materials for fire-resistive joint systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

## 1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install fire-resistive joint systems when ambient or substrate temperatures are outside limits permitted by fire-resistive joint system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate fire-resistive joint systems per manufacturer's written instructions by natural means or, if this is inadequate, forced-air circulation.

## 1.8 COORDINATION

- A. Coordinate construction and sizing of joints to ensure that fire-resistive joint systems are installed according to specified requirements.

## 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 Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the products specified.
    - a. Fire-Resistive Joint Systems:
      - 1) A/D Fire Protection Systems Inc.
      - 2) Firestop Systems Inc.
      - 3) Hilti, Inc.
      - 4) International Protective Coatings Corp.
      - 5) ISOLATEK International.
      - 6) 3M Fire Protection Products.
      - 7) Tremco, Inc.
      - 8) United States Gypsum Company.
    - b. Perimeter Fire-Containment Systems:
      - 1) Specified Technologies Inc.
      - 2) United States Gypsum Company.

### 2.2 FIRE-RESISTIVE JOINT SYSTEMS, GENERAL

- A. Compatibility: Provide fire-resistive joint systems that are compatible with joint substrates, under conditions of service and application, as demonstrated by fire-resistive joint system manufacturer based on testing and field experience.
- B. Accessories: Provide components of fire-resistive joint systems, including forming materials, that are needed to install fill materials and to comply with Part 1 "Performance Requirements" Article. Use only components specified by fire-resistive joint system manufacturer and approved by the qualified testing and inspecting agency for systems indicated.

## 2.3 FIRE-RESISTIVE JOINT SYSTEMS

- A. Where UL-classified fire-resistive joint systems are indicated, they refer to alphanumeric designations listed in UL's "Fire Resistance Directory" under product Category XHBN.
- B. Head-of-Wall Concrete Masonry Units, Fire-Resistive Joint System FRJS:
  - 1. Available UL-Classified Products: Wall to Floor and Wall to Roof:
    - a. HW-D-0022.
    - b. HW-D-0009.
  - 2. Assembly Rating: 2 hour.
  - 3. Nominal Joint Width: 1 inch.
  - 4. Movement Capabilities: Class I – 18.75 percent compression or extension.
- C. Head of Gypsum Wallboard/Stud Wall, Fire Resistive Joint System FRJS:
  - 1. UL Classified Products: Wall to Floor:
    - a. HW-D-0020.
    - b. HW-D-0029.
    - c. HW-D-0003.
  - 2. Assembly Rating: 1 hour.
  - 3. Nominal Joint Width: 1 inch.
  - 4. Movement Capabilities: Class I – 25 percent compression or extension.
- D. Head of Gypsum Wallboard/Stud Wall, Fire Resistive Joint System FRJS:
  - 1. UL Classified Products: Wall to Roof:
    - a. HW-D-0001.
    - b. HW-D-0003.
  - 2. Assembly Rating: 1 and 2 hour.
  - 3. Nominal Joint Width: 5/8 inch
  - 4. Movement Capabilities: Class II and III – 80% compression, 60% extension.
- E. Concrete Masonry Units, Wall-to-Wall in unfinished spaces, Fire-Resistive Joint System FRJS:
  - 1. UL-Classified Products:
    - a. WW-D-1033.

- b. WW-D-0004.
  - 2. Assembly Rating: 2 hour.
  - 3. Nominal Joint Width: 1 to 2 inches.
  - 4. Movement Capabilities: Class II – 12.5 percent compression or extension.
- F. Concrete Masonry Units, Wall-to-Wall in finished spaces, Fire-Resistive Joint System FRJS:
- 1. UL-Classified Products:
    - a. WW-D-0003.
  - 2. Assembly Rating: 2 hour.
  - 3. Nominal Joint Width: 1 to 2 inches.
  - 4. Movement Capabilities: Class II and III – 50 percent compression, extension or vertical shear.
- G. Gypsum Wall Board/Stud Wall-to-Wall in unfinished spaces, Fire-Resistive Joint System FRJS:
- 1. UL-Classified Products:
    - a. WW-S-0004 (for double layer GWB systems).
  - 2. Assembly Rating: 2 hour.
  - 3. Nominal Joint Width: 3/4 inch maximum.
  - 4. Movement Capabilities: Unclassified.
- H. Gypsum Wallboard/Stud, Wall-to-Wall in finished spaces, Fire-Resistive Joint System FRJS:
- 1. UL-Classified Products:
    - a. WW-D-0002.
    - b. WW-D-0005.
  - 2. Assembly Rating:
    - a. 1-hour (Single layer GWB each side).
    - b. 2-hour (Double layer GWB each side).
  - 3. Nominal Joint Width: 1 to 2 inches.
  - 4. Movement Capabilities: Class II and III – 50 percent compression, extension or vertical shear.

## PART 3 EXECUTION

### 3.1 EXAMINATION

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

### 3.2 PREPARATION

- A. Surface Cleaning: Clean joints immediately before installing fire-resistive joint systems to comply with fire-resistive joint system manufacturer's written instructions and the following requirements:
  - 1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of fill materials.
  - 2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with fill materials. Remove loose particles remaining from cleaning operation.
  - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by fire-resistive joint system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent fill materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from fire-resistive joint system materials. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

### 3.3 INSTALLATION

- A. General: Install fire-resistive joint systems to comply with Part 1 "Performance Requirements" Article and fire-resistive joint system manufacturer's written installation instructions for products and applications indicated.
- B. Install forming/packing/backing materials and other accessories of types required to support fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
- C. Install fill materials for fire-resistive joint systems by proven techniques to produce the following results:
  - 1. Fill voids and cavities formed by openings and forming/packing/backing materials as required to achieve fire-resistance ratings indicated.
  - 2. Apply fill materials so they contact and adhere to substrates formed by joints.
  - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

### 3.4 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to joints as Work progresses by methods and with cleaning materials that are approved in writing by fire-resistive joint system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure fire-resistive joint systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire-resistive joint systems immediately and install new materials to produce fire-resistive joint systems complying with specified requirements.

END OF SECTION

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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 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.
  - 4. Preformed joint sealants.
  - 5. Acoustical joint sealants.
- B. Related Sections:
  - 1. Division 04 Section "Unit Masonry" for masonry control and expansion joint fillers and gaskets.
  - 2. Division 07 Section "Fire-Resistive Joint Systems" for sealing joints in fire-resistance-rated construction.
  - 3. Division 08 Section "Glazing" for glazing sealants.
  - 4. Division 09 Section "Gypsum Board" for sealing perimeter joints.
  - 5. Division 09 Section "Acoustical Panel Ceilings" for sealing edge moldings at perimeters with acoustical sealant.

#### 1.3 PRECONSTRUCTION TESTING

- A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.
  - 1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
  - 2. Submit not fewer than eight pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
  - 3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.

4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.
  5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching those submitted.
- B. Preconstruction Field-Adhesion Testing: Before installing sealants, field test their adhesion to Project joint substrates as follows:
1. Locate test joints where indicated on Project or, if not indicated, as directed by Architect.
  2. Conduct field tests for each application indicated below:
    - a. Each kind of sealant and joint substrate indicated.
  3. Notify Architect seven days in advance of dates and times when test joints will be erected.
  4. Arrange for tests to take place with joint-sealant manufacturer's technical representative present.
    - a. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
      - 1) For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
  5. Report whether sealant failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. For sealants that fail adhesively, retest until satisfactory adhesion is obtained.
  6. Evaluation of Preconstruction Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered satisfactory. Do not use sealants that fail to adhere to joint substrates during testing.

#### 1.4 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.
- C. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2 inch (13 mm) wide joints formed between two 6 inch (150 mm) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- D. Joint-Sealant Schedule: Include the following information:

1. Joint-sealant application, joint location, and designation.
  2. Joint-sealant manufacturer and product name.
  3. Joint-sealant formulation.
  4. Joint-sealant color.
- E. Qualification Data: For qualified Installer and testing agency.
- F. Product Certificates: For each kind of joint sealant and accessory, from manufacturer.
- G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that sealants comply with requirements.
- H. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:
1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
  2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
- I. Preconstruction Field-Adhesion Test Reports: Indicate which sealants and joint preparation methods resulted in optimum adhesion to joint substrates based on testing specified in "Preconstruction Testing" Article.
- J. Field-Adhesion Test Reports: For each sealant application tested.
- K. 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.
- C. Product Testing: Test joint sealants using a qualified testing agency.
1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
- D. Mockups: Install sealant in mockups of assemblies specified in other Sections that are indicated to receive joint sealants specified in this Section. Use materials and installation methods specified in this Section.
- E. Pre-installation Conference: Conduct conference at Project site.

## 1.6 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (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.

## 1.7 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: Two years from date of Substantial Completion.
- B. Special 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 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. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):
  1. Architectural Sealants: 250 g/L.
  2. Sealant Primers for Nonporous Substrates: 250 g/L.
  3. Sealant Primers for Porous Substrates: 775 g/L.

- C. 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.
  - 1. Suitability for Immersion in Liquids. Where sealants are indicated for Use I for joints that will be continuously immersed in liquids, provide products that have undergone testing according to ASTM C 1247. Liquid used for testing sealants is deionized water, unless otherwise indicated.
- D. 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.
- E. Suitability for Contact with Food: Where sealants are indicated for joints that will come in repeated contact with food; provide products that comply with 21 CFR 177.2600.
- F. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

## 2.2 SILICONE JOINT SEALANTS

- A. Single-Component, Nonsag, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, 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; 790.
    - b. GE Advanced Materials - Silicones; SilPruf LM SCS2700.
    - c. Pecora Corporation; 890 NST.
    - d. Sika Corporation, Construction Products Division; SikaSil-C990.
    - e. Tremco Incorporated; Spectrem 1.
- B. Single-Component, Nonsag, Traffic-Grade, Neutral-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 100/50, for Use T.
  - 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; 790.
    - b. Pecora Corporation; 301 NS.
    - c. Tremco Incorporated; Spectrem 800.
- C. Mildew-Resistant, Single-Component, Acid-Curing Silicone Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, 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. BASF Building Systems; Omniplus.

- b. Dow Corning Corporation; 786 Mildew Resistant.
- c. GE Advanced Materials - Silicones; Sanitary SCS1700.
- d. May National Associates, Inc.; Bondaflex Sil 100 WF.
- e. Tremco Incorporated; Tremsil 200 Sanitary.

## 2.3 URETHANE JOINT SEALANTS

- A. Immersible, Single-Component, Nonsag, Traffic-Grade, Urethane Joint Sealant: ASTM C 920, Type S, Grade NS, Class 25, for Uses T and I.
  - 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 NP1.
    - b. Sika Corporation, Construction Products Division; Sikaflex - 1a.
    - c. Tremco Incorporated; Vulkem 116.

## 2.4 LATEX JOINT SEALANTS

- A. Latex Joint Sealant: Acrylic latex or siliconized acrylic latex, 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.

## 2.5 ACOUSTICAL JOINT SEALANTS

- A. Acoustical Joint Sealant: Manufacturer's standard nonsag, paintable, nonstaining latex sealant complying with ASTM C 834. Product effectively reduces airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.
  - 1. 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; AIS-919.
    - b. USG Corporation; SHEETROCK Acoustical Sealant.

## 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) Type B (bicellular material with a surface skin) or any of the preceding types, as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint. Provide self-adhesive tape where applicable.

## 2.7 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.
  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. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  1. Do not leave gaps between ends of sealant backings.



2. Do not stretch, twist, puncture, or tear sealant backings.
  3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and backs of joints.
- E. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
1. Place sealants so they directly contact and fully wet joint substrates.
  2. Completely fill recesses in each joint configuration.
  3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
1. Remove excess sealant from surfaces adjacent to joints.
  2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
  3. Provide concave joint profile per Figure 8A in ASTM C 1193, unless otherwise indicated.
    - a. Use masking tape to protect surfaces adjacent to recessed tooled joints.
- G. Acoustical Sealant Installation: At sound-rated assemblies and elsewhere as indicated, seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations.

### 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.
    - b. Perform 1 test for each 1000 feet (300 m) of joint length thereafter or 1 test per each floor per elevation.
  2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM 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: Exterior joints in horizontal traffic surfaces.
1. Joint Locations:
    - a. Isolation and contraction joints in cast-in-place concrete slabs.
    - b. Tile control and expansion joints.

- c. Joints between different materials listed above.
    - d. Other joints as indicated.
  2. Silicone Joint Sealant: Single component, nonsag, traffic grade, neutral curing.
  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.
  1. Joint Locations:
    - a. Construction joints in cast-in-place concrete.
    - b. Control and expansion joints in unit masonry.
    - c. Joints in glass unit masonry assemblies.
    - d. Joints between metal panels.
    - e. Joints between different materials listed above.
    - f. Perimeter joints between materials listed above and frames of doors windows and louvers.
    - g. Control and expansion joints in ceilings and other overhead surfaces.
    - h. Other joints as indicated.
  2. Silicone Joint Sealant: Single component, nonsag, neutral curing, Class 100/50.
  3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- C. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.
  1. Joint Locations:
    - a. Isolation joints in cast-in-place concrete slabs.
    - b. Control and expansion joints in tile flooring.
    - c. Other joints as indicated.
  2. Silicone Joint Sealant: Single component, nonsag, traffic grade, neutral curing.
  3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- D. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces.
  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 concrete walls and partitions.
    - e. Perimeter joints between interior wall surfaces and frames of interior doors windows.
    - f. Other joints as indicated.
  2. Joint Sealant: Latex.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- E. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Sealant Location:
    - a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
    - b. Tile control and expansion joints where indicated.
    - c. Other joints as indicated.
  2. Joint Sealant: [Single component, nonsag, mildew resistant, acid curing.
  3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.
- F. Joint-Sealant Application: Interior acoustical joints in vertical surfaces and horizontal nontraffic surfaces.
1. Joint Location:
    - a. Acoustical joints where indicated.
    - b. Other joints as indicated.
  2. Joint Sealant: Acoustical.
  3. Joint-Sealant Color: As selected by Architect from manufacturer's full range.

END OF SECTION

## SECTION 081113 - HOLLOW METAL DOORS AND FRAMES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes:
  - 1. Interior standard steel doors and frames.
  - 2. Exterior standard steel doors and frames.
- B. Related Requirements:
  - 1. Section 087100 "Door Hardware" for door hardware for hollow-metal doors.

#### 1.2 DEFINITIONS

- A. Minimum Thickness: Minimum thickness of base metal without coatings in accordance with NAAMM-HMMA 803 or ANSI/SDI A250.8.

#### 1.3 COORDINATION

- A. Coordinate anchorage installation for hollow-metal frames. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors. Deliver such items to Project site in time for installation.
- B. Coordinate requirements for installation of door hardware, electrified door hardware, and access control and security systems.

#### 1.4 PREINSTALLATION MEETINGS

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

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, core descriptions, fire-resistance ratings, and finishes.
- B. Shop Drawings: Include the following:
  - 1. Elevations of each door type.
  - 2. Details of doors, including vertical- and horizontal-edge details and metal thicknesses.

3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
  4. Locations of reinforcement and preparations for hardware.
  5. Details of each different wall opening condition.
  6. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
  7. Details of anchorages, joints, field splices, and connections.
  8. Details of accessories.
  9. Details of moldings, removable stops, and glazing.
- C. Samples for Initial Selection: For hollow-metal doors and frames with factory-applied color finishes.
- D. Samples for Verification:
1. Finishes: For each type of exposed finish required, prepared on Samples of not less than 3 by 5 inches.
  2. Fabrication: Prepare Samples approximately 12 by 12 inches to demonstrate compliance with requirements for quality of materials and construction:
    - a. Doors: Show vertical-edge, top, and bottom construction; core construction; and hinge and other applied hardware reinforcement. Include separate section showing glazing if applicable.
    - b. Frames: Show profile, corner joint, floor and wall anchors, and silencers. Include separate section showing fixed hollow-metal panels and glazing if applicable.
- E. Product Schedule: For hollow-metal doors and frames, prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with final door hardware schedule.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For door inspector.
1. Fire-Rated Door Inspector: Submit documentation of compliance with NFPA 80, Section 5.2.3.1.
  2. Egress Door Inspector: Submit documentation of compliance with NFPA 101, Section 7.2.1.15.4.
  3. Submit copy of DHI Fire and Egress Door Assembly Inspector (FDAI) certificate.
- B. Product Test Reports: For each type of fire-rated hollow-metal door and frame assembly for tests performed by a qualified testing agency indicating compliance with performance requirements.
- C. Field quality control reports.

## 1.7 CLOSEOUT SUBMITTALS

- A. Record Documents: For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.

## 1.8 QUALITY ASSURANCE

- A. Fire-Rated Door Inspector Qualifications: Inspector for field quality control inspections of fire-rated door assemblies is to meet the qualifications set forth in NFPA 80, section 5.2.3.1 and the following:
  - 1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.
- B. Egress Door Inspector Qualifications: Inspector for field quality control inspections of egress door assemblies is to meet the qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:
  - 1. Door and Hardware Institute Fire and Egress Door Assembly Inspector (FDAI) certification.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver hollow-metal doors and frames palletized, packaged, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.
  - 1. Provide additional protection to prevent damage to factory-finished units.
- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow-metal doors and frames vertically under cover at Project site with head up. Place on minimum 4-inch high wood blocking. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide steel doors and frames from an SDI Certified manufacturer:
  - 1. CECO Door Products.
  - 2. Curries Company.
  - 3. Steelcraft.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
  - 1. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.
- B. Fire-Rated, Borrowed-Lite Assemblies: Assemblies complying with NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing in accordance with NFPA 257 or UL 9.

## 2.3 INTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.
- B. Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 2; ANSI/SDI A250.4, Level B.
  - 1. Doors:
    - a. Type: As indicated in the Door and Frame Schedule.
    - b. Thickness: 1-3/4 inches.
    - c. Face: Uncoated steel sheet, minimum thickness of 0.042 inch.
    - d. Edge Construction: Model 1, Full Flush.
    - e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
    - f. Core: Polystyrene, Polyurethane, or Polyisocyanurate.
    - g. Fire-Rated Core: Manufacturer's standard laminated mineral board core for fire-rated doors.
  - 2. Frames:
    - a. Materials: Uncoated steel sheet, minimum thickness of 0.053 inch.
    - b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
    - c. Construction: Fully welded.
  - 3. Exposed Finish: Painted

## 2.4 EXTERIOR STANDARD STEEL DOORS AND FRAMES

- A. Construct hollow-metal doors and frames to comply with standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, and clearances, and as specified.



- B. Extra-Heavy-Duty Doors and Frames: ANSI/SDI A250.8, Level 3; ANSI/SDI A250.4, Level A.
  - 1. Doors:
    - a. Type: As indicated in the Door and Frame Schedule.
    - b. Thickness: 1-3/4 inches.
    - c. Face: Metallic-coated steel sheet, minimum thickness of 0.053 inch with A60 coating.
    - d. Edge Construction: Model 1, Full Flush.
    - e. Edge Bevel: Provide manufacturer's standard beveled or square edges.
    - f. Top Edge Closures: Close top edges of doors with flush closures of same material as face sheets. Seal joints against water penetration.
    - g. Bottom Edges: Close bottom edges of doors with end closures or channels of same material as face sheets. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape.
    - h. Core: Vertical steel stiffener.
  - 2. Frames:
    - a. Materials: Metallic-coated steel sheet, minimum thickness of 0.053 inch with A60 coating.
    - b. Sidelite and Transom Frames: Fabricated from same thickness material as adjacent door frame.
    - c. Construction: Fully welded.
  - 3. Exposed Finish: Painted.

## 2.5 BORROWED LITES

- A. Fabricate of uncoated steel sheet for interior locations and metallic-coated steel sheet for exterior locations, minimum thickness of 0.053 inch.
- B. Construction: Fully welded.
- C. Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as metal as frames.
- D. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.

## 2.6 FRAME ANCHORS

- A. Jamb Anchors:
  - 1. Type: Anchors of minimum size and type required by applicable door and frame standard, and suitable for performance level indicated.

2. Quantity: Minimum of three anchors per jamb, with one additional anchor for frames with no floor anchor. Provide one additional anchor for each 24 inches of frame height above 7 feet.
  3. Post-installed Expansion Anchor: Minimum 3/8-inch- diameter bolts with expansion shields or inserts, with manufacturer's standard pipe spacer.
- B. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor.
- C. Floor Anchors for Concrete Slabs with Underlayment: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at top of underlayment.
- D. Material: ASTM A879/A879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.
1. For anchors built into exterior walls, steel sheet complying with ASTM A1008/A1008M or ASTM A1011/A1011M; hot-dip galvanized in accordance with ASTM A153/A153M, Class B.

## 2.7 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A1008/A1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A1011/A1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated Steel Sheet: ASTM A653/A653M, Commercial Steel (CS), Type B.
- D. Inserts, Bolts, and Fasteners: Hot-dip galvanized in accordance with ASTM A153/A153M.
- E. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow-metal frames of type indicated.

## 2.8 FABRICATION

- A. Door Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted or as required to comply with published listing of qualified testing agency.
- B. Hollow-Metal Frames: Fabricate in one piece except where handling and shipping limitations require multiple sections. Where frames are fabricated in sections, provide alignment plates or angles at each joint, fabricated of metal of same or greater thickness as frames.

1. Sidelite and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by welding, or by rigid mechanical anchors.
  2. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
  3. Door Silencers: Except on weather-stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
    - a. Single-Door Frames: Drill stop in strike jamb to receive three door silencers.
    - b. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- C. Hardware Preparation: Factory prepare hollow-metal doors and frames to receive templated mortised hardware, and electrical wiring; include cutouts, reinforcement, mortising, drilling, and tapping in accordance with ANSI/SDI A250.6, the Door Hardware Schedule, and templates.
1. Reinforce doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.
  2. Comply with BHMA A156.115 for preparing hollow-metal doors and frames for hardware.
- D. Glazed Lites: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with mitered hairline joints.
1. Provide stops and moldings flush with face of door, and with beveld stops unless otherwise indicated.
  2. Multiple Glazed Lites: Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.
  3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames. Provide loose stops and moldings on inside of hollow-metal doors and frames.
  4. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.
  5. Provide stops for installation with countersunk flat- or oval-head machine screws spaced uniformly not more than 9 inches o.c. and not more than 2 inches o.c. from each corner.

## 2.9 STEEL FINISHES

- A. Prime Finish: Clean, pretreat, and apply manufacturer's standard primer.
1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.

- B. Factory Finish: Clean, pretreat, and apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat, complying with ANSI/SDI A250.3.
  - 1. Color and Gloss: As selected by Architect from manufacturer's full range.

## 2.10 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces. Touch up factory-applied finishes where spreaders are removed.
- B. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

## 2.11 INSTALLATION

- A. Install hollow-metal doors and frames plumb, rigid, properly aligned, and securely fastened in place. Comply with approved Shop Drawings and with manufacturer's written instructions.
- B. Hollow-Metal Frames: Comply with ANSI/SDI A250.11.
  - 1. Set frames accurately in position; plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces without damage to completed Work.
    - a. Where frames are fabricated in sections, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces. Touch-up finishes.
    - b. Install frames with removable stops located on secure side of opening.
  - 2. Fire-Rated Openings: Install frames in accordance with NFPA 80.
  - 3. Floor Anchors: Secure with postinstalled expansion anchors.
    - a. Floor anchors may be set with power-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
  - 4. Solidly pack mineral-fiber insulation inside frames.
  - 5. Masonry Walls: Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout or mortar.
  - 6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
  - 7. Installation Tolerances: Adjust hollow-metal frames to the following tolerances:
    - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

- b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
  - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
  - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow-Metal Doors: Fit and adjust hollow-metal doors accurately in frames, within clearances specified below.
  - 1. Non-Fire-Rated Steel Doors: Comply with ANSI/SDI A250.8.
  - 2. Fire-Rated Doors: Install doors with clearances in accordance with NFPA 80.
  - 3. Smoke-Control Doors: Install doors in accordance with NFPA 105.

## 2.12 FIELD QUALITY CONTROL

- A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
  - 1. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
  - 2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80.

## 2.13 REPAIR

- A. Prime-Coat Touchup: Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air-drying, rust-inhibitive primer.
- B. Metallic-Coated Surface Touchup: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.
- C. Factory-Finish Touchup: Clean abraded areas and repair with same material used for factory finish according to manufacturer's written instructions.
- D. Touchup Painting: Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION

## SECTION 081416 - FLUSH WOOD DOORS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Solid-core doors with wood-veneer faces.
  - 2. Factory finishing flush wood doors.
  - 3. Factory fitting flush wood doors to frames and factory machining for hardware.
- B. Related Requirements:
  - 1. Section 087100 "Door Hardware" for hardware sets in flush wood doors.
  - 2. Section 088000 "Glazing" for glass view panels in flush wood doors.
  - 3. Section 088813 "Fire-Resistant Glazing" for glass view panels in flush wood doors.
  - 4. Section 099100 "Painting" for field finishing doors.

#### 1.3 PREINSTALLATION MEETINGS

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

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product, including the following:
  - 1. Door core materials and construction.
  - 2. Door edge construction
  - 3. Door face type and characteristics.
  - 4. Factory finishing specifications.
- B. Shop Drawings: Indicate location, size, and hand of each door; elevation of each type of door; construction details not covered in Product Data; and the following:
  - 1. Door elevations, dimension and locations of hardware, lite and louver cutouts, and glazing thicknesses.
  - 2. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems.
  - 3. Dimensions and locations of blocking for hardware attachment.
  - 4. Dimensions and locations of mortises and holes for hardware.

5. Clearances and undercuts.
  6. Requirements for veneer matching.
  7. Doors to be factory finished and application requirements.
  8. Fire-protection rating for fire-rated doors.
- C. Samples for Initial Selection: For factory-finished doors.
- D. Samples for Verification:
1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.
  2. Corner sections of doors, approximately 8 by 10 inches, with door faces and edges representing actual materials to be used.
    - a. Provide Samples for each species of veneer and solid lumber required.
    - b. Finish veneer-faced door Samples with same materials proposed for factory-finished doors.
  3. Frames for light openings, 6 inches long, for each material, type, and finish required.
- 1.5 INFORMATIONAL SUBMITTALS
- A. Sample Warranty: For special warranty.
- 1.6 QUALITY ASSURANCE
- A. Manufacturer's Certification: A certification that manufacturer that has been in continuous door manufacturing for the last 10 years.
- B. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies shall comply with qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:
1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.
- C. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of egress door assemblies shall comply with qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:
1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Comply with requirements of referenced standard and manufacturer's written instructions.



- B. Package doors individually in cardboard cartons, and wrap bundles of doors in plastic sheeting.
- C. Mark each door on bottom rail with opening number used on Shop Drawings.

## 1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and HVAC system is operating and maintaining temperature and relative humidity at levels designed for building occupants for the remainder of construction period.

## 1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace doors that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Delamination of veneer.
    - b. Warping (bow, cup, or twist) more than 1/4-inch in a 42-by-84-inch section.
    - c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
  - 2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
  - 3. Warranty Period for Solid-Core Interior Doors: Life of installation.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. 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. Algoma Hardwoods, Inc.
  - 2. Eggers Industries.
  - 3. Marshfield Door Systems, Inc.
  - 4. Mohawk Flush Doors, Inc.; a Masonite company.
  - 5. VT Industries Inc.
- B. Source Limitations: Obtain flush wood doors from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Low-Emitting Materials: Fabricate doors with adhesives and composite wood products that do not contain urea formaldehyde.

- B. Fire-Rated Wood Door Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated on Drawings, based on testing at positive pressure in accordance with UL 10C or NFPA 252.
  - 1. Oversize Fire-Rated Door Assemblies: For units exceeding sizes of tested assemblies, provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.
  - 2. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
  - 3. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
- C. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.

## 2.3 FLUSH WOOD DOORS, GENERAL

- A. Quality Standard: In addition to requirements specified, comply with AWI's, AWMAC's, and WI's "Architectural Woodwork Standards."
  - 1. Provide Labels indicating that doors comply with requirements of grades specified.
  - 2. Contract Documents contain selections chosen from options in quality standard and additional requirements beyond those of quality standard. Comply with those selections and requirements in addition to quality standard.

## 2.4 SOLID-CORE FLUSH WOOD VENEER-FACED DOORS FOR TRANSPARENT FINISH

- A. Interior Doors:
  - 1. Performance Grade: ANSI/WDMA I.S. 1A Extra Heavy Duty.
  - 2. Grade: Custom.
  - 3. Faces: Grade A.
    - a. Species: Selected from manufacturer's full range of species.
    - b. Cut: Rift cut.
    - c. Match between Veneer Leaves: Slip match.
    - d. Assembly of Veneer Leaves on Door Faces: Running match.
  - 4. Exposed Vertical Edges: Applied wood edges of same species as faces and covering edges of crossbands - edge Type D.
- B. Particleboard-Core Doors:

1. Particleboard: ANSI A208.1, Grade LD-2, made with binder containing no urea-formaldehyde.
  2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware.
    - a. 5-inch top-rail blocking, in doors indicated to have closers.
    - b. 5-inch bottom-rail blocking, in exterior doors and doors indicated to have kick, mop, or armor plates.
    - c. 5-inch mid-rail blocking, in doors indicated to have exit devices.
- C. Mineral-Core Doors:
1. Core: Noncombustible mineral product complying with requirements of referenced quality standard and testing and inspecting agency for fire-protection rating indicated.
  2. Blocking: Provide composite blocking with improved screw-holding capability approved for use in doors of fire-protection ratings indicated as needed to eliminate through-bolting hardware.
    - a. 5-inch top-rail blocking.
    - b. 5-inch bottom-rail blocking, in doors indicated to have protection plates.
    - c. 5-inch mid-rail blocking, in doors indicated to have armor plates.
  3. Edge Construction: At hinge stiles, provide laminated-edge construction with improved screw-holding capability and split resistance. Comply with specified requirements for exposed edges.
  4. Construction: Five (5) plies, hot-pressed bonded (vertical and horizontal edging is bonded to core), with entire unit abrasive planed before veneering.

## 2.5 LIGHT FRAMES

- A. Wood Beads for Light Openings in Wood Doors: Provide manufacturer's standard wood beads unless otherwise indicated.
1. Wood Species: Same species as door faces.
  2. Profile: Flush rectangular beads.
  3. At wood-core doors with 20-minute fire-protection ratings, provide wood beads and metal glazing clips approved for such use.
- B. Metal Frames for Light Openings in Fire-Rated Doors: Manufacturer's standard frame formed of 0.048-inch thick, cold-rolled steel sheet; factory primed for paint finish; and approved for use in doors of fire-protection rating indicated on Drawings.

## 2.6 FABRICATION

- A. Factory fit doors to suit frame-opening sizes indicated.
1. Comply with clearance requirements of referenced quality standard for fitting unless otherwise indicated.
  2. Comply with NFPA 80 requirements for fire-rated doors.

- B. Factory machine doors for hardware that is not surface applied.
  - 1. Locate hardware to comply with DHI-WDHS-3.
  - 2. Comply with final hardware schedules, door frame Shop Drawings, ANSI/BHMA-156.115-W, and hardware templates.
  - 3. Coordinate with hardware mortises in metal frames, to verify dimensions and alignment before factory machining.
  - 4. For doors scheduled to receive electrified locksets, provide factory-installed raceway and wiring to accommodate specified hardware.
  - 5. Metal Astragals: Factory machine astragals and formed-steel edges for hardware for pairs of fire-rated doors.
- C. Openings: Factory cut and trim openings through doors.
  - 1. Light Openings: Trim openings with moldings of material and profile indicated.
  - 2. Glazing: Factory install glazing in doors indicated to be factory finished. Comply with applicable requirements in Section 088000 "Glazing."

## 2.7 FACTORY FINISHING

- A. Comply with referenced quality standard for factory finishing.
  - 1. Complete fabrication, including fitting doors for openings and machining for hardware that is not surface applied, before finishing.
  - 2. Finish faces, all four edges, edges of cutouts, and mortises.
  - 3. Stains and fillers may be omitted on bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Factory finish doors that are indicated on Drawings to receive transparent finish.
- D. Factory finish doors where indicated in schedules or on Drawings as factory finished.
- E. Transparent Finish:
  - 1. Grade: Custom
  - 2. Finish: ANSI/WDMA I.S. 1A TR-6 Catalyzed Polyurethane.
  - 3. Staining: As selected by Architect from manufacturer's full range.
  - 4. Effect: Semi-filled finish, produced by applying an additional finish coat to partially fill the wood pores.
  - 5. Sheen: Satin.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine doors and installed door frames, with Installer present, before hanging doors.

1. Verify that installed frames comply with indicated requirements for type, size, location, and swing characteristics and have been installed with level heads and plumb jambs.
  2. Reject doors with defects.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Hardware: For installation, see Section 087100 "Door Hardware."
- B. Install doors to comply with manufacturer's written instructions and referenced quality standard, and as indicated.
1. Install fire-rated doors and frames in accordance with NFPA 80.
  2. Install smoke- and draft-control doors in accordance with NFPA 105.
- C. Job-Fitted Doors:
1. Align and fit doors in frames with uniform clearances and bevels as indicated below.
    - a. Do not trim stiles and rails in excess of limits set by manufacturer or permitted for fire-rated doors.
  2. Machine doors for hardware.
  3. Seal edges of doors, edges of cutouts, and mortises after fitting and machining.
  4. Clearances:
    - a. Provide 1/8-inch at heads, jambs, and between pairs of doors.
    - b. Provide 1/8-inch from bottom of door to top of decorative floor finish or covering unless otherwise indicated on Drawings.
    - c. Where threshold is shown or scheduled, provide 1/4-inch from bottom of door to top of threshold unless otherwise indicated.
    - d. Comply with NFPA 80 for fire-rated doors.
  5. Bevel non-fire-rated doors 1/8-inch in 2 inches at lock and hinge edges.
  6. Bevel fire-rated doors 1/8-inch in 2 inches at lock edge; trim stiles and rails only to extent permitted by labeling agency.
- D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

### 3.3 FIELD QUALITY CONTROL

- A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:

1. Provide inspection of installed Work through AWI's Quality Certification Program, certifying that wood doors and frames, including installation, comply with requirements of AWI/AWMCA/WI's "Architectural Woodwork Standards" for the specified grade.
  2. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80.

### 3.4 ADJUSTING

- A. Operation: Rehang or replace doors that do not swing or operate freely.
- B. Finished Doors: Replace doors that are damaged or that do not comply with requirements. Doors may be repaired or refinished if Work complies with requirements and shows no evidence of repair or refinishing.

END OF SECTION

## SECTION 083343 - OVERHEAD COILING SMOKE CURTAINS

### 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. Smoke and fire protective curtain assemblies for window openings.

#### 1.3 PREINSTALLATION MEETINGS

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

#### 1.4 COORDINATION

- A. Coordinate smoke curtain assemblies with power, signal, fire alarm, and smoke detection systems specified in Division 26 and Division 28.
- B. Coordinate smoke protective curtain assemblies with ceilings for operational clearances and maintenance access requirements.
- C. Coordinate smoke protective curtain assemblies with walls for support requirements, rating continuity above ceilings, and recessed wall switches.
- D. Coordinate requirements for metal supports required for smoke protective curtain assemblies.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of smoke protective curtain assembly and draft curtain.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for smoke curtains.
  - 2. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
  - 3. Include ratings, operating components, electrical characteristics, control systems, and furnished specialties and accessories.
- B. Shop Drawings: For each installation and for special components not dimensioned or detailed in manufacturer's product data.

1. Include plans, elevations, sections, and attachment details.
  2. Include details of smoke curtain assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location of each field connection.
  3. Include points of attachment and their corresponding static and dynamic loads imposed on structure.
  4. Detail fabrication and assembly of fire protective curtain assemblies.
  5. Show locations of controls, detectors, and other accessories.
  6. Include diagrams for power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified, 6 inches in length.
- D. Samples for Initial Selection: Manufacturer's finish charts showing full range of material and finish options available for units with factory-applied finishes.
1. Curtain guide.
  2. Bottom bar.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, manufacturer, testing agency, and factory-authorized service representative.
- B. Evaluation Reports: For curtain assemblies, from ICC-ES.
- C. Field quality-control reports.
- D. Sample Warranty: For manufacturer's special warranty.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For smoke and fire protective curtain assemblies to include in emergency, operation, and maintenance manuals.
- B. Field quality-control reports for required testing.

#### 1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: An entity experienced in manufacturing smoke and draft control curtain assemblies that have been successfully installed in compliance with requirements of authorities having jurisdiction.
- B. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer for both installation and maintenance of units required for this Project.



- C. Smoke Protective Curtain Assembly Inspector Qualifications: Inspector for field quality control inspections of smoke protective curtain assemblies complying with NFPA 105.

## 1.9 FIELD CONDITIONS

- A. Field Measurements: Field-verify and coordinate dimensions and indicate measurements on Shop Drawings.

## 1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of curtain assemblies that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Two years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS, GENERAL

- A. Source Limitations: Obtain smoke protective curtains from single source from single manufacturer.
  - 1. Obtain operators and controls from smoke protective curtain manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Smoke and Fire Protective Curtain Assemblies: Complying with NFPA 80; listed and labeled by qualified testing agency, for fire protection ratings indicated, based on testing at as close to neutral pressure as possible in accordance with UL 10D.
  - 1. Smoke Control: Provide smoke protective curtains that are listed and labeled with the letter "S" on the rating label by a qualified testing agency for smoke and draft control based on testing in accordance with UL 1784; with maximum air-leakage rate of 3.0 cfm/sq. ft. of opening at 0.10 inch wg for both ambient and elevated temperature tests.
- B. Curtain Fabric Fire Test Response Characteristics: Provide products that pass NFPA 701, as determined by testing of fabrics that were treated using treatment-application method intended for use for this Project by a testing and inspecting agency acceptable to authorities having jurisdiction.
- 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.

### 2.3 SMOKE AND FIRE PROTECTIVE CURTAIN ASSEMBLIES FOR WINDOW OPENINGS

- A. Alarm activated flame resistant fabric smoke curtain assembly complying with ICC-ES A77.
- B. Basis of Design Product: Subject to compliance with requirements, provide 1 Hour Fire Protective Smoke Curtain with Egress model SD60GS manufactured by U.S. Smoke and Fire, or a comparable product by one of the following:
  - 1. Door Systems
  - 2. Fire Curtain Technologies.
  - 3. McKeon Rolling Steel Door Company, Inc.
  - 4. Modernfold Styles, Inc.
- C. Smoke Containment: Assemblies complying with UL 1784 for air leakage and requirements of ASME 17.1/CSA B44.
- D. Fire Resistance Rating of Fabric: Comply with UL 10D; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - 1. Rating: 1-hour.
- E. Operation: Motorized automatic operation with controlled descent.
- F. Automatic-Closing Device: Equip each deployable curtain assembly with fail-safe, gravity-closing device or holder-release mechanism and governor unit complying with UL 325 and NFPA 105, and an easily tested and reset release mechanism. Automatic-closing device shall be designed for activation by the following:
  - 1. Manufacturer's standard UL-labeled smoke detector and holder release devices.
  - 2. Manufacturer's standard UL-labeled heat detector and holder release devices.
  - 3. Building fire detection, smoke detection, and fire alarm systems.
- G. Hood/Head Box: Manufactured from galvanized steel in accordance with ASTM A653/A653M; rated at the same temperature as the curtain fabric.
- H. Curtain: Manufacturer's standard multilayer glass-fiber fabric woven-coated on one or both sides.
  - 1. Fire Rating: UL-listed fabric tested in accordance with UL 10D and ASTM E119 for 1-hour fire resistance.
- I. Roller: Manufacturer's standard curtain roller assembly to contain motor.
- J. Weighted Bottom Bar: Provide weighted bottom bar to ensure smooth operation and hold curtain taut.
- K. Curtain Guides: As selected by Architect from manufacturer's available standard materials and finishes.

- L. Motor Operator: Provide factory-assembled electric operation system of size and capacity recommended by curtain manufacturer for assembly specified, with electric motors and factory-prewired motor controls, control devices, and accessories required for proper operation.
  - 1. Include wiring from control stations to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.
  - 2. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 3. Battery Backup: Manufacturer's standard battery backup sized for motor power requirements.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrate areas and conditions, with Installer present, for compliance with requirements for substrate construction and other conditions affecting performance of the Work.
- B. Examine locations of electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Smoke and Fire Protective Curtains: Install in accordance with manufacturer's written installation instructions, NFPA 80, and NFPA 105.
- B. Smoke Protective Curtains: Install smoke protective curtain assemblies in accordance with manufacturer's written installation instructions and NFPA 105.
- C. Power Operated Curtains: Install in accordance with UL 325.
- D. Install anchorage devices to securely fasten assembly to substrate and building framing without distortion or stress.
- E. Securely brace components suspended from structure.
- F. Fit and align assembly, including vertical guides, level and plumb, to provide smooth operation.

#### 3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified opening protective assembly inspector to perform tests and inspections and to furnish reports to Architect.

- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Test release mechanism, closing, and alarm operations when activated by smoke detector or building's fire alarm system. Test manual operation of closed curtain. Reset closing mechanism after successful test.
  - 2. Inspections: Inspect each smoke protective curtain assembly in accordance with NFPA 105.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each smoke fire protective curtain assembly indicating compliance with each item listed in NFPA 105.

#### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain overhead coiling smoke curtains.

#### 3.5 MAINTENANCE

- A. Engage a manufacturer's authorized service representative to test, adjust, and maintain the smoke protective assemblies once per year, as required by NFPA 105.

END OF SECTION

## SECTION 083453 - SECURITY DOORS

### SECTION INCLUDES

#### 1.1 Bullet resistant aluminum door assemblies.

- A. Bullet resistant steel door assemblies.
- B. Bullet resistant wood door assemblies.
- C. Bullet resistant divided lite wood door assemblies.

#### 1.2 REFERENCES

- A. Underwriters Laboratory UL 752-Standard for Bullet Resisting Equipment.
- B. ASTM C 1172 - Standard Specification for Laminated Architectural Flat Glass.
- C. ASTM B 209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- D. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of framing including manufacturer recommended installation instructions.
- B. Shop Drawings: Include plans, elevations, sections, details, attachment to other work.
- C. Samples: For each exposed finish.

#### 1.4 INFORMATION SUBMITTALS

- A. Product Test Reports: Indicating compliance with requirements.
- B. Warranty: Sample of finish warranty

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

#### 1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the project site with the manufacturer's UL Listed Labels intact and legible. Handle the materials with care to prevent damage. Store materials inside and under cover, stack flat and off floor. Project conditions (temperature, humidity, and ventilation) shall be within the maximum limit recommendations provided by manufacturer. Do not install products stored in conditions outside manufacturer's recommended limits.

## 1.7 WARRANTY

- 1. Finish Warranty: Manufacturer's warranty against deterioration of factory finishes for the period of 10 years from the date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURED UNITS

- A. Basis of Design: Subject to compliance with requirements, provide aluminum Exterior Transaction Window by Total Security Solutions, or a comparable product by one of the following:
  - 1. [Armortex, Inc.](#)
  - 2. [C.R. Laurence Co., Inc.](#)
  - 3. [Chicago Bullet Proof Systems.](#)
  - 4. Diebold, Incorporated
  - 5. [Krieger Specialty Products Company.](#)
  - 6. Laurance, C.R. Company, Inc.
  - 7. [Quikserv Corp.](#)
  - 8. [Ready Access.](#)
- B. Design Performance:
  - 1. Aluminum Door assemblies shall be constructed of extruded aluminum in 6061-T6 alloy/tempered.
  - 2. Steel Door assemblies shall be of the non-ricochet type. This design is intended to permit the retention of an attacking projectile lessening the potential of a random injury or lateral penetration.
  - 3. Wood Door and Wood Divided Lite Door assemblies shall be constructed of a wood core lined with a sheet of fiberglass.
  - 4. Door and shall to have no exposed fasteners.
  - 5. Corner joints shall consist of extruded and keyed aluminum spline with continuous 3/8" diameter steel tie rod at door top and bottom rails.
  - 6. All joints and connections shall be tight, providing hairline points and true alignment of adjacent members.
  - 7. Panels shall not be removable from threat side.
- C. Door and Frame Assembly Dimensions: As indicated on the Drawings.

- D. Door and Frame Performance:
  - 1. Standard door assembly shall be manufactured to defeat ballistic assaults in accordance with UL Standard 752, Level 3.
  - 2. Door assembly stiles, top rails and bottom rails shall be lined with hardened steel to meet Level 4 and 5 UL standards.

## 2.2 ALUMINUM DOOR UNITS

- A. Aluminum Doors:
  - 1. Top rail and stile: 2-3/4".
  - 2. Bottom rail, including glass stops: 8-1/2".
  - 3. Aluminum Door and Sidelight Frames and Extrusions: 1-3/4" x 4" with structural section .125" thick.
- B. Factory-applied finish:
  - 1. Clear Anodic Finish: Architectural Class I, clear coating AA-M10C22A41  
Mechanical Finish Chemical Finish: etched, medium matte; 0.70 mils minimum complying with AAMA 611 "Voluntary Specification for Anodized Architectural Aluminum"
  - 2. Color Anodic Finish: Architectural Class I, color coating AA-M10C22A42/A44  
Mechanical Finish Chemical Finish: etched, medium matte; 0.70 mils minimum complying with AAMA 611 "Voluntary Specification for Anodized Architectural Aluminum".
  - 3. Baked-Enamel or Powder-Coat Finish: [AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.]
- C. Field alterations to the construction of the assembly fabricated under the acceptable standards are not allowed unless approved in writing by the manufacturer and the Architect.
- D. Standard manufacturing tolerances +/- 1/16" shall be maintained.

## 2.3 STEEL DOOR UNITS

- A. Steel Doors:
  - 1. Rails and stiles shall be fully welded to face plates and provide a flush surface on all edges.
  - 2. Door unit shall be pre-hung with a continuous gear hinge in a steel frame.
  - 3. Door and frame shall be mortised and reinforced at the factory for template hardware per hardware schedule.
  - 4. Peepholes, view windows and door scopes shall be pre-drilled and factory installed.
    - a. Finishes:

5. Primed and painted at factory.

## 2.4 WOOD CORE DOOR UNITS

- A. Finishes:
  1. Wood Veneer: As selected from manufacturer's standard range of options.

## 2.5 DIVIDED LIGHT WOOD DOOR UNITS

- A. Finishes:
  1. Wood Veneer: As selected from manufacturer's standard range of options.

## 2.6 MISCELLANEOUS

- A. Finishes:
  1. Glazing: Polycarbonate/Acrylic Laminate to comply with UL 752, Level 4 protection.
- B. Door Hardware:
  1. Refer to Specification Section 087100 – "Door Hardware"

## 2.7 PERFORMANCE CRITERIA

- A. Ballistic Resistant:
  1. Level 4 in accordance with UL 752 – Testing for Ballistic Resistance for the complete assembly including framing, glazing and panels.

## 2.8 FABRICATION

- A. Aluminum sections to be manufactured in accordance with ASTM B209, Extruded aluminum alloy 6063 T5 Anodized to match the existing décor and be free of sharp edges or burrs when in place.
- B. Glazing Channel: U-Channel specifically designed for securing transparencies tightly in place. Angles and stops are only acceptable for top attachment. All exposed aluminum edges shall be clean cut and have no burrs. Exposed corners shall be rounded and sanded.
- C. Tolerances: All joints and connections shall be tight, providing hairline joints and true alignment of adjacent members

## 2.9 ACCESSORIES

- A. Anchors: Fully concealed manufacturer recommended.



## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Prior to beginning installation, verify that all supports have been installed as required by the Contract Documents and architectural drawings, and Shop Drawings have been approved.
- B. Notify Architect of any unsatisfactory preparation that is responsibility of others.
- C. Clean and prepare all surfaces per manufacturers recommendations as required for achieving the best results for the substrate under the project conditions.
- D. Verify field dimensions of openings prior to fabrication of framing.
- E. Coordinate structural requirements to ensure proper attachment and support.
- F. Do not begin installation of material until all unsatisfactory conditions have been resolved and approved by Architect.

### 3.2 INSTALLATION

- A. Do not begin installation until openings have been verified and surfaces properly prepared in accordance with Drawings.
- B. Install in accordance with manufacturer's instructions and UL 752. Set all equipment plumb.
- C. All products shall be installed per installation instructions provided by manufacturer.
- D. Door and frame assembly shall arrive on site completely pre-fabricated to field dimensions approved by Shop Drawings.
- E. Install framing and secure to structure in accordance with manufacturer's recommendations and approved shop drawings.
- F. Provide required support and securely fasten and set doors and frame plumb, square, and level without twist or bow.
- G. Apply sealant in accordance with manufacturer's recommendations as indicated in installation instructions.
- H. Remove excess sealant and leave exposed surfaces clean and smooth.
- I. Bullet Resistant Wood Door Assemblies shall be installed using, industrial adhesive, mastic, screws and bolts. Method of application shall maintain bullet resistive rating at junctures with concrete floor, door and window frames and other penetrations.

### 3.3 PROTECTION

- A. Clean and protect door and frame assembly from damage during ongoing construction operations. If damage occurs, remove and replace as required to provide assembly in their original, undamaged condition.
- B. Inspection and Cleaning: Verify installation is complete and complies with manufacturer's requirements.
- C. Provide final cleaning of product and accessories, removing excess sealant, labels and protective covers.
- D. Touch-up, repair or replace damaged products prior to Substantial Completion.

END OF SECTION

## SECTION 084113 - ALUMINUM FRAMED ENTRANCES AND STOREFRONTS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Aluminum-framed storefront systems.
  - 2. Aluminum-framed entrance door systems.

#### 1.2 ALLOWANCES

#### 1.3 PREINSTALLATION MEETINGS

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

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.
  - 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
  - 2. Include full-size isometric details of each type of vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
    - a. Joinery, including concealed welds.
    - b. Anchorage.
    - c. Expansion provisions.
    - d. Glazing.
    - e. Flashing and drainage.
  - 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
  - 4. Include point-to-point wiring diagrams showing the following:
    - a. Power requirements for each electrically operated door hardware.
    - b. Location and types of switches, signal device, conduit sizes, and number and size of wires.

- C. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.
- D. Fabrication Sample: Of each vertical-to-horizontal intersection of assemblies, made from 12-inch lengths of full-size components and showing details of the following:
  - 1. Joinery, including concealed welds.
  - 2. Anchorage.
  - 3. Expansion provisions.
  - 4. Glazing.
  - 5. Flashing and drainage.
- E. Delegated Design Submittal: For aluminum-framed entrances and storefronts including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data:
  - 1. For Installer.
  - 2. For professional engineer's experience with providing delegated design engineering services of the kind indicated, including documentation that engineer is licensed in the state in which Project is located.
- B. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by manufacturer and witnessed by a qualified testing agency.
- C. Sample Warranties: For special warranties.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.
- B. Maintenance Data for Structural Sealant: For structural-sealant-glazed storefront to include in maintenance manuals. Include ASTM C1401 recommendations for post-installation-phase quality-control program.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer and that employs a qualified glazing contractor for this Project who is certified under the North American Contractor Certification Program (NACC) for Architectural Glass & Metal (AG&M) contractors.

- B. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
  - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.
- C. Structural-Sealant Glazing: Comply with ASTM C1401 for design and installation of entrances and storefronts systems that include structural glazing.

## 1.8 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures, including, but not limited to, excessive deflection.
    - b. Noise or vibration created by wind and thermal and structural movements.
    - c. Water penetration through fixed glazing and framing areas.
    - d. Failure of operating components.
  - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 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. Warranty Period: 10 years from date of Substantial Completion.
- C. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
  - 1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Delta E units when tested in accordance with ASTM D 2244.
    - b. Chalking in excess of a No. 8 rating when tested in accordance with ASTM D 4214.
    - c. Cracking, peeling, or chipping.

2. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design aluminum-framed entrances and storefronts.
- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
  1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure, including, but not limited to, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
  2. Failure also includes the following:
    - a. Thermal stresses transferring to building structure.
    - b. Glass breakage.
    - c. Noise or vibration created by wind and thermal and structural movements.
    - d. Loosening or weakening of fasteners, attachments, and other components.
    - e. Failure of operating units.
- C. Structural Loads:
  1. Wind Loads: As indicated on Drawings.
- D. Deflection of Framing Members Supporting Glass: At design wind load, as follows:
  1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans of up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches.
  2. Deflection Parallel to Glazing Plane: Limited to amount not exceeding that which reduces glazing bite to less than 75 percent of design dimension and that which reduces edge clearance between framing members and glazing or other fixed components to less than 1/8 inch.
- E. Structural: Test in accordance with ASTM E330/E330M as follows:

1. When tested at positive and negative wind-load design pressures, storefront assemblies, including entrance doors, do not evidence deflection exceeding specified limits.
  2. When tested at 150 percent of positive and negative wind-load design pressures, storefront assemblies, including entrance doors and anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
- F. Water Penetration under Static Pressure: Test in accordance with ASTM E331 as follows:
1. No evidence of water penetration through fixed glazing and framing areas, including entrance doors, when tested in accordance with a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure.
- G. Water Penetration under Dynamic Pressure: Test in accordance with AAMA 501.1 as follows:
1. No evidence of water penetration through fixed glazing and framing areas when tested at dynamic pressure equal to 20 percent of positive wind-load design pressure.
  2. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters, or water that is drained to exterior.
- H. Energy Performance: Certified and labeled by manufacturer for energy performance as follows:
1. Air Leakage:
    - a. Fixed Glazing and Framing Areas: Air leakage for the system of not more than 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft. when tested in accordance with ASTM E283.
    - b. Entrance Doors: Air leakage of not more than [1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.
- I. Ballistics Resistance, UL 752: Level 8 when tested in accordance with UL 752.
- J. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes.
1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.
  2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested in accordance with AAMA 501.5.
- K. Structural-Sealant Joints:
1. Designed to carry gravity loads of glazing.

- L. Structural Sealant: ASTM C1184. Capable of withstanding tensile and shear stresses imposed by structural-sealant-glazed, aluminum-framed entrances and storefronts without failing adhesively or cohesively. When tested for preconstruction adhesion and compatibility, cohesive failure of sealant shall occur before adhesive failure.
  - 1. Adhesive failure occurs when sealant pulls away from substrate cleanly, leaving no sealant material behind.
  - 2. Cohesive failure occurs when sealant breaks or tears within itself but does not separate from each substrate, because sealant-to-substrate bond strength exceeds sealant's internal strength.

## 2.3 NON-RATED STOREFRONT SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer, An Arconic Company, or comparable product by one of the following:
  - 1. EFCO, LLC.
  - 2. Oldcastle Infrastructure, Inc.
  - 3. TRACO.
  - 4. Vistawall Architectural Products
  - 5. YKK AP America, Inc.
- B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
- C. Framing System Basis-of-Design:
  - 1. Exterior Applications: Kawneer Trifab 451UT Framing System
    - a. Framing Construction: Thermally broken.
    - b. Glazing System: Retained mechanically with gaskets on four sides.
    - c. Glazing Plane: Center
    - d. Finish: Clear anodic finish, Color anodic finish, baked-enamel, or powder-coat finish.
    - e. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
    - f. Steel Reinforcement: As required by manufacturer.
- D. Security Booth/Room Applications: Kawneer Trifab VersaGlaze 601T Framing System
  - a. Framing Construction: Thermally broken.
  - b. Glazing System: Retained mechanically with gaskets on four sides.
  - c. Glazing Plane: Front or Center.
  - d. Finish: Clear anodic finish, Color anodic finish, baked-enamel, or powder-coat finish.
  - e. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
  - f. Steel Reinforcement: As required by manufacturer.



2. All Other Interior Applications: Kawneer Trifab VersaGlaze 451T Framing System
  - a. Framing Construction: Thermally broken.
  - b. Glazing System: Retained mechanically with gaskets on four sides.
  - c. Glazing Plane: Front, Back, or Center.
  - d. Finish: Clear anodic finish, Color anodic finish, baked-enamel, or powder-coat finish.
  - e. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
  - f. Steel Reinforcement: As required by manufacturer.
  - g. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
  - h. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

## 2.4 NON-RATED ENTRANCE DOOR SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Kawneer, An Arconic Company, or comparable product by one of the following:
  1. EFCO, LLC.
  2. Oldcastle Infrastructure, Inc.
  3. TRACO.
  4. Vistawall Architectural Products.
  5. YKK AP America, Inc.
- B. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing or automatic operation.
  1. Door Construction: 1-3/4-inch overall thickness, with minimum 0.125-inch thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
    - a. Thermal Construction: High-performance plastic connectors separate aluminum members exposed to the exterior from members exposed to the interior.
- C. Door Design: Wide stile; 5-inch nominal width.
- D. Glazing Stops and Gaskets: Snap-on, extruded-aluminum stops and preformed gaskets.

## 2.5 Finish: Match adjacent storefront framing finish.

## 2.6 FIRE-RATED STOREFRONT SYSTEMS

- 2.7 Basis-of-Design Product: Subject to compliance with requirements, provide Technical Glass Products (TPG), or comparable product by one of the following:
1. EFCO, LLC.
  2. Kawneer, An Arconic Company.
  3. Oldcastle Infrastructure, Inc.
  4. Safti First, Safety And Fire Technology Inc.
  5. TRACO.
  6. Vistawall Architectural Products.
  7. YKK AP America, Inc.
- B. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
1. Framing System Basis-of-Design:
    - a. Interior Fire-Rated Applications (Stairways): Technical Glass Products (TGP) Fireframes Designer Series.
- C. Steel Framing System including doors and storefronts with fire-rating as indicated on drawings.
1. Frame: Steel profiled formed tubing.
  2. Fasteners: As recommended by manufacturer
  3. Glazing Accessories: calcium silicate setting blocks.
- D. Fire-Rated Storefront Assemblies: Assemblies complying with NFPA 80 that are classified and labeled by UL, for fire ratings indicated, based on testing according to NFPA 257. Assemblies must be factory-welded or come complete with factory-installed mechanical joints and must not require job site fabrication.
- E. Fire Rating Requirements: Capable of providing fire-rating as indicated on drawings.
- F. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- G. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.

## 2.8 FIRE-RATED ENTRANCE DOOR SYSTEMS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Technical Glass Products (TPG), or comparable product by one of the following:
1. EFCO, LLC.
  2. Kawneer, An Arconic Company.
  3. Oldcastle Infrastructure, Inc.
  4. Safti First, Safety And Fire Technology Inc.
  5. TRACO.

6. Vistawall Architectural Products.
7. YKK AP America, Inc.

- B. Fire-Rated Door Assemblies: Assemblies complying with NFPA 80 that are classified and labeled by UL, for fire ratings indicated, based on testing according to NFPA 252. Assemblies must be factory-welded or come complete with factory-installed mechanical joints and must not require job site fabrication.
- C. Fire Rating Requirements: Capable of providing a fire-rating as indicated on drawings.
  1. When glazed with fire-rated glazing products, doors meet the maximum transmitted temperature rise of not more than 450 degrees Fahrenheit at the end of 30 minutes of the standard fire test exposure.

## 2.9 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Refer to Section 087100 "Door Hardware."
- B. Fire Rated Hardware: Shall be provided by manufacturer to meet fire-rating as indicated on drawings.

## 2.10 GLAZING

- A. Glazing: Comply with Section 088000 "Glazing."
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.
- C. Glazing Sealants: As recommended by manufacturer.
- D. Structural Glazing Sealants: ASTM C1184 chemically curing silicone formulation that is compatible with system components with which it comes in contact; specifically formulated and tested for use as structural sealant and approved by structural-sealant manufacturer for use in storefront system indicated.
  1. Color: As selected by Architect from manufacturer's full range of colors.
- E. Weatherseal Sealants: ASTM C920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed storefront manufacturers for this use.
  1. Color: Match structural sealant.

## 2.11 MATERIALS

- A. Sheet and Plate: ASTM B209.
- B. Extruded Bars, Rods, Profiles, and Tubes: ASTM B221.

- C. Structural Profiles: ASTM B308/B308M.
- D. Steel Reinforcement:
  - 1. Structural Shapes, Plates, and Bars: ASTM A36/A36M.
  - 2. Cold-Rolled Sheet and Strip: ASTM A1008/A1008M.
  - 3. Hot-Rolled Sheet and Strip: ASTM A1011/A1011M.
- E. Steel Reinforcement Primer: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods in accordance with recommendations in SSPC-SP COM, and prepare surfaces in accordance with applicable SSPC standard.

## 2.12 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
  - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
  - 2. Reinforce members as required to receive fastener threads.
- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
  - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A123M or ASTM A153/A153M requirements.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.
- E. Rigid PVC filler.

## 2.13 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
  - 1. Profiles that are sharp, straight, and free of defects or deformations.

2. Accurately fitted joints with ends coped or mitered.
  3. Physical and thermal isolation of glazing from framing members.
  4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
  5. Provisions for field replacement of glazing from interior.
  6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.
- F. Storefront Framing: Fabricate components for assembly using screw-spline system.
- G. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
1. At interior and exterior doors, provide compression weather stripping at fixed stops.
- H. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
  2. At exterior doors, provide weather sweeps applied to door bottoms.
- I. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- J. After fabrication, clearly mark components to identify their locations in Project in accordance with Shop Drawings.

## 2.14 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm thicker.
1. Color: As selected by Architect from full range of industry colors and color densities.
- B. Color Anodic Finish: AAMA 611, AA-M12C22A44, Class I, 0.018 mm thicker.
1. Color: As selected by Architect from full range of industry colors and color densities.
- C. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
1. Color and Gloss: As selected by Architect from manufacturer's full range.

## 2.15 SOURCE QUALITY CONTROL

- A. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

## PART 3 EXECUTION

### 3.1 EXAMINATION

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

### 3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions.
- B. Do not install damaged components.
- C. Fit joints to produce hairline joints free of burrs and distortion.
- D. Rigidly secure nonmovement joints.
- E. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
- F. Seal perimeter and other joints watertight unless otherwise indicated.
- G. Metal Protection:
  - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
  - 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- H. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.
- I. Install joint filler behind sealant as recommended by sealant manufacturer.
- J. Install components plumb and true in alignment with established lines and grades.

### 3.3 INSTALLATION OF GLAZING

- A. Install glazing as specified in Section 088000 "Glazing."

### 3.4 INSTALLATION OF STRUCTURAL GLAZING

- A. Prepare surfaces that will contact structural sealant in accordance with sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.
- B. Set glazing into framing in accordance with sealant manufacturer and framing manufacturer's written instructions and standard practice. Use a spacer or backer as recommended by manufacturer.
- C. Set glazing with proper orientation so that coatings face exterior or interior as specified.
- D. Hold glazing in place using temporary retainers of type and spacing recommended by manufacturer, until structural sealant joint has cured.
- E. Apply structural sealant to completely fill cavity, in accordance with sealant manufacturer and framing manufacturer's written instructions and in compliance with local codes.
- F. Apply structural sealant at temperatures indicated by sealant manufacturer for type of sealant.
- G. Allow structural sealant to cure in accordance with manufacturer's written instructions.
- H. Clean and protect glass as indicated in Section 088000 "Glazing."

### 3.5 INSTALLATION OF WEATHERSEAL SEALANT

- A. After structural sealant has completely cured, remove temporary retainers and insert backer rod between lites of glass as recommended by sealant manufacturer.
- B. Install weatherseal sealant to completely fill cavity, in accordance with sealant manufacturer's written instructions, to produce weatherproof joints.

### 3.6 INSTALLATION OF ALUMINUM-FRAMED ENTRANCE DOORS

- A. Install entrance doors to produce smooth operation and tight fit at contact points.
  - 1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
  - 2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware in accordance with entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

### 3.7 ERECTION TOLERANCES

- A. Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:
1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
  2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
  3. Alignment:
    - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
    - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
    - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
  4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

END OF SECTION



## SECTION 085113 - ALUMINUM WINDOWS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes aluminum windows for exterior locations.
- B. Related Requirements:
  - 1. Section 084113 "Aluminum-Framed Entrances and Storefronts" for coordinating finish among aluminum fenestration units.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 2. Review and discuss the finishing of aluminum windows that is required to be coordinated with the finishing of other aluminum work for color and finish matching.
  - 3. Review, discuss, and coordinate the interrelationship of aluminum windows with other exterior wall components. Include provisions for anchoring, flashing, weeping, sealing perimeters, and protecting finishes.
  - 4. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
  - 5. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.
- B. Shop Drawings: For aluminum windows.

1. Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.
- C. Samples for Initial Selection: For units with factory-applied finishes.
  1. Include Samples of hardware and accessories involving color selection.
- D. Samples for Verification: For aluminum windows and components required, showing full range of color variations for finishes, and prepared on Samples of size indicated below:
  1. Exposed Finishes: 2 by 4 inches
  2. Exposed Hardware: Full-size units.
- E. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer and Installer.
- B. Product Test Reports: For each type of aluminum window, for tests performed by a qualified testing agency.
- C. Field quality-control reports.
- D. Sample Warranties: For manufacturer's warranties.

#### 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports and calculations.
- B. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project.

#### 1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace aluminum windows that fail in materials or workmanship within specified warranty period.
  1. Failures include, but are not limited to, the following:
    - a. Failure to meet performance requirements.
    - b. Structural failures including excessive deflection, water leakage, condensation, and air infiltration.
    - c. Faulty operation of movable sash and hardware.
    - d. Deterioration of materials and finishes beyond normal weathering.

- e. Failure of insulating glass.
- 2. Warranty Period:
  - a. Window: 10 years from date of Substantial Completion.
  - b. Glazing Units: 10 years from date of Substantial Completion.
  - c. Aluminum Finish: 10 years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain aluminum windows from single source from single manufacturer.

### 2.2 WINDOW PERFORMANCE REQUIREMENTS

- A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.
  - 1. Window Certification: AAMA certified with label attached to each window.
- B. Performance Class and Grade: AAMA/WDMA/CSA 101/I.S.2/A440 as follows:
  - 1. Minimum Performance Class: LC
  - 2. Minimum Performance Grade: 25
- C. Thermal Transmittance: NFRC 100 maximum whole-window U-factor of 0.45 Btu/sq. ft. x h x deg F.
- D. Solar Heat-Gain Coefficient (SHGC): NFRC 200 maximum whole-window SHGC of 0.38
- E. Condensation-Resistance Factor (CRF): Provide aluminum windows tested for thermal performance according to AAMA 1503, showing a CRF of 45.
- F. Thermal Movements: Provide aluminum windows, including anchorage, that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
  - 1. Temperature Change: 120 deg F ambient; 180 deg F material surfaces
- G. Outside-Inside Transmission Class (OITC): Rated for not less than 26 OITC when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E1332.
- H. Windborne-Debris Impact Resistance: Passes ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone 3 for basic protection.

## 2.3 ALUMINUM WINDOWS

- A. Basis of Design Product: Subject to compliance with requirements, provide Optiq AA 5450 Series Windows manufactured by Kawneer, An Arconic Company, or a comparable product by one of the following:
  - 1. EFCO, LLC.
  - 2. Oldcastle Infrastructure, Inc.
  - 3. TRACO.
  - 4. Vistawall Architectural Products
  - 5. YKK AP America, Inc.
- B. Types: Provide the following types in locations indicated on Drawings:
  - 1. Casement: Outswing
  - 2. Single hung.
  - 3. Double hung.
  - 4. Horizontal sliding.
  - 5. Fixed.
- C. Frames and Sashes: Aluminum extrusions complying with AAMA/WDMA/CSA 101/I.S.2/A440.
  - 1. Thermally Improved Construction: Fabricate frames, sashes, and muntins with an integral, concealed, low-conductance thermal barrier located between exterior materials and window members exposed on interior side in a manner that eliminates direct metal-to-metal contact.
- D. Glass: Refer to glass types indicated on drawings and as specified in Division 08 glazing specification sections.
- E. Glazing System: Manufacturer's standard factory-glazing system that produces weathertight seal.
- F. Hardware, General: Provide manufacturer's standard hardware fabricated from aluminum, stainless steel, carbon steel complying with AAMA 907, or other corrosion-resistant material compatible with adjacent materials; designed to smoothly operate, tightly close, and securely lock windows, and sized to accommodate sash weight and dimensions.
  - 1. Exposed Hardware Color and Finish: As selected by Architect from manufacturer's full range.
- G. Casement Window Hardware:
  - 1. Gear-Type Rotary Operators: Complying with AAMA 901 when tested according to ASTM E405, Method A. Provide operators that function without requiring the removal of interior screens or using screen wickets.

- a. Type and Style: As selected by Architect from manufacturer's full range of types and styles.
    2. Hinges: Non-friction type, not less than two per sash
    3. Lock: Concealed multipoint lock operated by single lever handle or lift-type throw.
    4. Limit Devices: Concealed support arms with adjustable, limited, hold-open limit devices designed to restrict sash opening.
      - a. Limit clear opening to 4 inches for ventilation; with custodial key release.
  - H. Hung Window Hardware:
    1. Counterbalancing Mechanism: Complying with AAMA 902, concealed, of size and capacity to hold sash stationary at any open position.
    2. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.
    3. Tilt Latch: Releasing latch allows sash to pivot about horizontal axis to facilitate cleaning exterior surfaces from the interior.
  - I. Horizontal-Sliding Window Hardware:
    1. Sill Cap/Track: Manufacturer's standard of dimensions and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.
    2. Locks and Latches: Allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.
    3. Roller Assemblies: Low-friction design.
  - J. Weather Stripping: Provide full-perimeter weather stripping for each operable sash unless otherwise indicated.
  - K. Fasteners: Noncorrosive and compatible with window members, trim, hardware, anchors, and other components.
    1. Exposed Fasteners: Do not use exposed fasteners to greatest extent possible. For application of hardware, use fasteners that match finish hardware being fastened.
- 2.4 ACCESSORIES
- A. Subsills: Thermally broken, extruded-aluminum subsills in configurations indicated on Drawings.
  - B. Interior Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.
  - C. Panning Trim: Extruded-aluminum profiles in sizes and configurations indicated on Drawings.
  - D. Receptor System: Two-piece, snap-together, thermally broken, extruded-aluminum receptor system that anchors windows in place.

## 2.5 INSECT SCREENS

- A. General: Fabricate insect screens to integrate with window frame. Provide screen for each operable exterior sash. Screen wickets are not permitted.
  - 1. Type and Location: Full - outside for double-hung, half -outside for single-hung, Half - outside for sliding sashes.
- B. Aluminum Frames: Manufacturer's standard aluminum alloy complying with SMA 1004 or SMA 1201. Fabricate frames with mitered or coped joints or corner extrusions, concealed fasteners, and removable PVC spline/anchor concealing edge of frame.
  - 1. Tubular Framing Sections and Cross Braces: Roll formed from aluminum sheet.
- C. Aluminum Wire Fabric: 18-by-16 mesh of 0.011-inch diameter, coated aluminum wire.
  - 1. Wire-Fabric Finish: Natural bright.

## 2.6 FABRICATION

- A. Fabricate aluminum windows in sizes indicated. Include a complete system for assembling components and anchoring windows.
- B. Glaze aluminum windows in the factory.
- C. Weather strip each operable sash to provide weathertight installation.
- D. Weep Holes: Provide weep holes and internal passages to conduct infiltrating water to exterior.
- E. Provide water-shed members above side-hinged sashes and similar lines of natural water penetration.
- F. Mullions: Provide mullions and cover plates, matching window units, complete with anchors for support to structure and installation of window units. Allow for erection tolerances and provide for movement of window units due to thermal expansion and building deflections. Provide mullions and cover plates capable of withstanding design wind loads of window units.
- G. Complete fabrication, assembly, finishing, hardware application, and other work in the factory to greatest extent possible. Disassemble components only as necessary for shipment and installation.

## 2.7 GENERAL FINISH REQUIREMENTS

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

- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## 2.8 ALUMINUM FINISHES

- A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- B. Finishes shall be selected by Architect from one of the following:
  - 1. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 611.
  - 2. Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker) complying with AAMA 611.
    - a. Color: As selected by Architect from full range of industry colors and color densities.
  - 3. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
    - a. Color: As selected by Architect from full range of industry colors and color densities.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.
- C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Comply with manufacturer's written instructions for installing windows, hardware, accessories, and other components. For installation procedures and requirements not addressed in manufacturer's written instructions, comply with installation requirements in ASTM E2112.
- B. Install windows level, plumb, square, true to line, without distortion or impeding thermal movement, anchored securely in place to structural support, and in proper relation to wall flashing and other adjacent construction to produce weathertight construction.
- C. Install windows and components to drain condensation, water penetrating joints, and moisture migrating within windows to the exterior.
- D. Separate aluminum and other corrodible surfaces from sources of corrosion or electrolytic action at points of contact with other materials.

### 3.3 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
  - 1. Testing and inspecting agency will interpret tests and state in each report whether tested work complies with or deviates from requirements.
- B. Testing Services: Testing and inspecting of installed windows shall take place as follows:
  - 1. Testing Methodology: Testing of windows for air infiltration and water resistance shall be performed according to AAMA 502.
  - 2. Air-Infiltration Testing:
    - a. Test Pressure: That required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance class indicated.
    - b. Allowable Air-Leakage Rate: 1.5 times the applicable AAMA/WDMA/CSA 101/I.S.2/A440 rate for product type and performance class rounded down to one decimal place.
  - 3. Water-Resistance Testing:
    - a. Test Pressure: Two-thirds times test pressure required to determine compliance with AAMA/WDMA/CSA 101/I.S.2/A440 performance grade indicated.
    - b. Allowable Water Infiltration: No water penetration.
  - 4. Testing Extent: Three windows of each type as selected by Architect and a qualified independent testing and inspecting agency. Windows shall be tested after perimeter sealants have cured.
  - 5. Test Reports: Prepared according to AAMA 502.
- C. Windows will be considered defective if they do not pass tests and inspections.



- D. Prepare test and inspection reports.

#### 3.4 ADJUSTING, CLEANING, AND PROTECTION

- A. Adjust operating sashes and hardware for a tight fit at contact points and weather stripping for smooth operation and weathertight closure.
- B. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
  - 1. Keep protective films and coverings in place until final cleaning.
- C. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
- D. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

END OF SECTION

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## SECTION 085653 - SECURITY WINDOWS

### 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. Fixed, transaction security windows and glazing.
- B. Related Requirements:
  - 1. Section 099100 "Painting" for field painting security windows.

#### 1.3 COORDINATION

- A. Coordinate installation of anchorages for security windows. 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 adjacent construction. Deliver such items to Project site in time for installation.

#### 1.4 PREINSTALLATION MEETINGS

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

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, weights and finishes for window units.
- B. Shop Drawings: For security windows.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Full-size section details of framing members, including internal armoring, reinforcement, and stiffeners.
  - 3. Hardware for sliding window units.
  - 4. Glazing details.
  - 5. Details of deal tray and speaking aperture.
- C. Samples for Initial Selection: For frame members with factory-applied color finishes.

- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of sizes indicated below:
  - 1. Framing: 12-inch long sections of frame members.
- E. Cutaway Sample: Corner of security window, made from 12-inch lengths of full-size components, and showing details of the following:
  - 1. Joinery.
  - 2. Anchorage.
  - 3. Glazing.
  - 4. Deal tray section.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Welding certificates.
- C. Product Test Reports: For each type of security window and accessory indicated as ballistics or forced-entry resistant, for tests performed by a qualified testing agency.
- D. Configuration Disclosure Drawing: For each type of forced-entry-resistant security window, complying with ASTM F1233.
- E. Examination reports documenting inspections of substrates, areas, and conditions.
- F. Anchor inspection reports documenting inspections of built-in and cast-in anchors.
- G. Field quality-control reports documenting inspections of installed products.
  - 1. Field quality-control certification signed by Contractor.
- H. Sample Warranty: For special warranty.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer for installation and maintenance of units required for this Project.
- 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 D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
  - 4. AWS D1.6, "Structural Welding Code - Stainless Steel."

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Pack security windows in wood crates for shipment. Crate glazing separate from frames unless factory glazed.
- B. Label security window packaging with drawing designation.
- C. Store crated security windows on raised blocks to prevent moisture damage.

## 1.9 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

## 1.10 SEQUENCING

- A. Field Painting (if applicable): Except where security windows have been pre-glazed before installation, complete field painting of security windows before glazing installation.

## 1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace security windows that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including deflections exceeding 1/4 inch.
    - b. Failure of welds.
    - c. Excessive air leakage.
    - d. Faulty operation of sliding window hardware.
    - e. Faulty operation of speaking aperture.
    - f. Faulty operation of deal tray flip cover.
    - g. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
  - 2. Warranty Period: One year from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Attack Resistance: Provide units identical to those tested for compliance with requirements indicated, and as follows:
  - 1. Ballistics Resistance: Level 4 when tested according to UL 752.
  - 2. Forced-Entry Resistance: Class III when tested according to ASTM F1233.
  - 3. Forced-Entry Resistance: 15 minute protection level when tested according to SD-STD-01.01.

- B. Air Infiltration: Provide windows with maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. of fixed wall area when tested according to ASTM E283 at a minimum static-air-pressure difference of 6.24 lbf/sq. ft.

## 2.2 FIXED, TRANSACTION SECURITY WINDOWS

- A. Provide fixed, transaction security windows with voice aperture and operable deal tray capable of allowing transfer of currency and documents.
  - 1. Basis of Design Product: Subject to compliance with requirements, provide aluminum Exterior Transaction Window by Total Security Solutions, or a comparable product by one of the following:
    - a. Armortex, Inc.
    - b. C.R. Laurence Co., Inc.
    - c. Chicago Bullet Proof Systems.
    - d. Diebold, Incorporated
    - e. Krieger Specialty Products Company.
    - f. Laurance, C.R. Company, Inc.
    - g. Quikserv Corp.
    - h. Ready Access.
- B. Configuration: One fixed-glazed panel.
- C. Framing: Fabricate perimeter framing, mullions, and glazing stops from aluminum as follows:
  - 1. Basis of Design Product: Subject to compliance with requirements, provide BL 5.5 Ballistic Framing by Total Security Solutions.
  - 2. Profile: Manufacturer's standard with minimum face dimension of 1-3/4 inches.
  - 3. Depth: Manufacturer's standard, minimum 5-1/2 inches.
  - 4. Opening Size: As indicated on drawings.
  - 5. Head and Jamb Framing: Bullet resistant aluminum and designed for sealant glazing to meet ballistics and forced entry requirements.
- D. Channel-Frame Sill: Designed for sealant glazing.
- E. Transaction Counter: Stainless steel, minimum 12 inches deep by width of security window, with integral deal tray with flip cover, centered in opening.
- F. Voice Transmission: Stainless steel, 6" diameter speaking aperture.
  - 1. Basis of Design Product: Subject to compliance with requirements, provide MK-1 Voice Port by Total Security Solutions.
- G. Glazing Assembly: To meet ballistics and forced entry requirements.
  - 1. Basis of Design Product: Subject to compliance with requirements, provide Glass-Clad Polycarbonate, No Spall, Bullet Resistant, Level 4 Glazing by Total Security Solutions.

2. Glazing Components: Overall Thickness 1 1/8 inch average.
  - a. Threat Side Layer 1 - Glazing: 3/8 inch Clear Glass
  - b. Threat Side Layer 2 – Coating: 0.05 Urethane
  - c. Interlayer Layer - Glazing: 3/8 inch Clear Glass
  - d. Secure Side Layer 1- Coating: 0.070 Urethane
  - e. Secure Side Layer 2- Glazing: 1/4 inch Mar Resistant Clear Polycarbonate
- H. Glazing Materials: Additional requirements comply with manufacturer's recommendations and Section 088853 "Security Glazing."
- I. Glazing Meeting Edges: Polished glazing.
- J. Materials:
  1. Mild Steel Plates, Shapes, and Bars: ASTM A36/A36M.
  2. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666 or ASTM A240/A240M, austenitic stainless steel, Type 304.
  3. Aluminum Extrusions: ASTM B221. Provide alloy and temper recommended by manufacturer for strength, corrosion resistance, and application of required finish, but not less than 22,000-psi ultimate tensile strength.
  4. Aluminum Sheet and Plate: ASTM B209.

## 2.3 FABRICATION

- A. General: Fabricate security windows to provide a complete system for assembly of components and anchorage of window units.
  1. Provide units that are re-glazable from the secure side without dismantling the attack side of framing.
  2. Prepare security windows for field glazing unless pre-glazing at the factory is indicated.
- B. Provide weep holes and internal water passages for exterior security windows to conduct infiltrating water to the exterior.
- C. Thermally Improved or Thermally Broken Construction: Fabricate framing with an integral, concealed, low-conductance thermal barrier, located between exterior materials and members exposed on interior in a manner that eliminates direct metal-to-metal contact.
- D. Framing: Miter or cope corners the full depth of framing; weld and dress smooth.
  1. Fabricate framing with manufacturer's standard, internal opaque armoring in thicknesses required for security windows to comply with ballistics-resistance performance indicated.
- E. Glazing Stops: Finish glazing stops to match security window framing.
  1. Threat-Side (Exterior) Glazing Stops: Welded or integral to framing.

2. Secure-Side (Interior) Glazing Stops: Removable, coordinated with glazing indicated.
- F. Welding: Weld components to comply with referenced AWS standard. To greatest extent possible, weld before finishing and in concealed locations to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- G. Metal Protection: Separate dissimilar metals to protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended by manufacturer for this purpose.
- H. Factory-cut openings in glazing for speaking apertures.
- I. Pre-glazed Fabrication: Pre-glaze window units at factory, where required for applications indicated. Installation orientation of glazing to meet performance requirements.
- J. Weather Stripping: Factory applied.

## 2.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## 2.5 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

## 2.6 STAINLESS-STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.
  1. Run grain of directional finishes with long dimension of each piece.
  2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
  3. Directional Satin Finish: No. 4.



## 2.7 ACCESSORIES

- A. Concealed Bolts: ASTM A307, Grade A unless otherwise indicated.
- B. Cast-in-Place Anchors in Concrete: Fabricated from corrosion-resistant materials capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing according to ASTM E488/E488M, conducted by a qualified testing agency; of type indicated below.
  - 1. Threaded or wedge type; galvanized ferrous castings, either ASTM A27/A27M cast steel or ASTM A47/A47M malleable iron. Provide bolts, washers, and shims as required; hot-dip galvanized according to ASTM A153/A153M or ASTM F2329/F2329M.
- C. Embedded Plate Anchors: Fabricated from mild steel shapes and plates, minimum 3/16 inch thick; with minimum 1/2-inch diameter, headed studs welded to back of plate.
- D. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- E. Glazing Strips and Weather Stripping: Manufacturer's standard replaceable components.
  - 1. Compression Type: Molded EPDM or neoprene gaskets complying with ASTM D2000, Designations 2BC415 to 3BC620; molded PVC gaskets complying with ASTM D2287; or molded, expanded EPDM or neoprene gaskets complying with ASTM C509, Grade 4.
  - 2. Sliding Type: AAMA 701/702, made of wool, polypropylene, or nylon woven pile with nylon-fabric backing.
- F. Miscellaneous Glazing Materials: Provide material, size, and shape complying with requirements of glass manufacturers and with a proven record of compatibility with surfaces contacted in installation.
  - 1. Cleaners, Primers, and Sealers: Type recommended by sealant or gasket manufacturer.
  - 2. Setting Blocks: Elastomeric material with a Shore A durometer hardness of 85, plus or minus 5.
  - 3. Spacers: Elastomeric blocks or continuous extrusions with a Shore A durometer hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
  - 4. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).
- G. Anchors, Clips, and Window Accessories: Stainless steel; hot-dip, zinc-coated steel or iron, complying with ASTM B633; provide sufficient strength to withstand design pressures indicated.

- H. Sealants: For sealants required within fabricated security windows, provide type recommended by manufacturer for joint size and movement. Sealant shall remain permanently elastic, non-shrinking, and nonmigrating.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of security windows.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations of security window connections before security window installation.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of security windows.
- D. Inspect built-in and cast-in anchor installations, before installing security windows, to verify that anchor installations comply with requirements. Prepare inspection reports.
  - 1. Remove and replace anchors where inspections indicate that they do not comply with specified requirements. Reinspect after repairs or replacements are made.
  - 2. Perform additional inspections to determine compliance of replaced or additional work. Prepare anchor inspection reports.
- E. For factory-installed glazing materials whose orientation (secure or attack side) is critical for performance, verify installation orientation.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Coordination: Furnish layouts for cast-in-place anchors, clips, and other security window anchors whose installation is specified in other Sections.
  - 1. Furnish cast-in-place anchors and similar devices to other trades for installation well in advance of time needed for coordinating other work.

### 3.3 INSTALLATION

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing security windows to in-place construction. Include threaded fasteners for inserts, security fasteners, and other connectors.
  - 1. Install an attached or integral flange to secure side of security windows extending over rough-in opening gap so that gap has same forced-entry-resistance and ballistics-resistance performance as security window.

- B. Glazed Framing: Provide sealant glazed framing.
- C. Removable Glazing Stops and Trim: Fasten components with security fasteners.
- D. Fasteners: Install security windows using fasteners recommended by manufacturer with head style appropriate for installation requirements, strength, and finish of adjacent materials. Provide stainless-steel fasteners in stainless-steel materials.
- E. Sealants: Comply with requirements in Section 079200 "Joint Sealants" for installing sealants, fillers, and gaskets.
  - 1. Set continuous sill members and flashing in a full sealant bed to provide weathertight construction unless otherwise indicated.
  - 2. Seal frame perimeter with sealant to provide weathertight construction unless otherwise indicated.
- F. Metal Protection: Where dissimilar metals will contact each other, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape recommended in writing by manufacturer for this purpose. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

### 3.4 FIELD QUALITY CONTROL

- A. Inspect installed products to verify compliance with requirements. Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.
- B. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.
- C. Prepare field quality-control certification that states installed products and their installation comply with requirements in the Contract Documents.

### 3.5 ADJUSTING

- A. Adjust horizontal-sliding, transaction security windows to provide a tight fit at contact points for smooth operation and a secure enclosure.
- B. Remove and replace defective work, including security windows that are warped, bowed, or otherwise unacceptable.

### 3.6 CLEANING AND PROTECTION

- A. Clean surfaces promptly after installation of security windows. Take care to avoid damaging the finish. Remove excess glazing and sealant compounds, dirt, and other substances.
  - 1. Lubricate sliding security window hardware.

2. Lubricate transaction drawer hardware.

- B. Clean glass of pre-glazed security windows promptly after installation. Comply with cleaning and maintenance requirements in Section 088000 "Glazing" and Section 088853 "Security Glazing."
- C. Provide temporary protection to ensure that security windows are without damage at time of Substantial Completion.

### 3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain operable security windows, speaking apertures, and voice transmission devices.

END OF SECTION

## 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 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section includes:
  - 1. Door hardware for:
    - a. Swinging doors.
- B. Related Sections:
  - 1. Division 07 Section "Joint Sealants" for sealant requirements applicable to threshold installation specified in this section.
  - 2. Division 09 Sections for touchup finishing or refinishing of existing openings modified by this section.

#### 1.3 REFERENCES

- A. Fire/Life Safety
  - 1. NFPA - National Fire Protection Association.
    - a. NFPA 70 – National Electric Code.
    - b. NFPA 80 - Standard for Fire Doors and Fire Windows.
    - c. NFPA 101 - Life Safety Code.
    - d. NFPA 105 - Smoke and Draft Control Door Assemblies.
  - 2. State Fire Safety Code.
- B. UL - Underwriters Laboratories
  - 1. UL 10B - Fire Test of Door Assemblies.
  - 2. UL 10C - Positive Pressure Test of Fire Door Assemblies.
  - 3. UL 1784 - Air Leakage Tests of Door Assemblies.
  - 4. UL 305 - Panic Hardware.
- C. Accessibility
  - 1. ADA - Americans with Disabilities Act .
  - 2. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
- D. DHI - Door and Hardware Institute
  - 1. Sequence and Format for the Hardware Schedule.

2. Recommended Locations for Builders Hardware.
3. Key Systems and Nomenclature.

E. ANSI - American National Standards Institute

1. ANSI/BHMA A156.1 - A156.29, and ANSI A156.31 - Standards for Hardware and Specialties.

## 1.4 SUBMITTALS

A. General:

1. Submit in accordance with Conditions of Contract and Division 01 requirements.
2. Highlight, encircle, or otherwise specifically identify on submittals deviations from Contract Documents, issues of incompatibility or other issues which may detrimentally affect the Work.
3. Prior to forwarding submittal, comply with procedures for verifying existing door and frame compatibility for new hardware, as specified in PART 3, "EXAMINATION" article, herein.

B. Action Submittals:

1. Product Data: Product data including manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
2. Samples for Verification: If requested by Architect, submit production sample or sample installations of each type of exposed hardware unit in finish indicated, and tagged with full description for coordination with schedule.
  - a. Samples will be returned to supplier in like-new condition. Units that are acceptable to Architect may, after final check of operations, be incorporated into Work, within limitations of key coordination requirements.
3. Door Hardware Schedule: Submit schedule with hardware sets in vertical format as illustrated by Sequence of Format for the Hardware Schedule as published by the Door and Hardware Institute. Indicate complete designations of each item required for each door or opening, include:
  - a. Door Index; include door number, heading number, and Architects hardware set number.
  - b. Opening Lock Function Spreadsheet: List locking device and function for each opening.
  - c. Type, style, function, size, and finish of each hardware item.
  - d. Name and manufacturer of each item.
  - e. Fastenings and other pertinent information.
  - f. Location of each hardware set cross-referenced to indications on Drawings.
  - g. Explanation of all abbreviations, symbols, and codes contained in schedule.
  - h. Mounting locations for hardware.

- i. Door and frame sizes and materials.
    - j. Name and phone number for local manufacturer's representative for each product.
  - 4. Key Schedule:
    - a. After Keying Conference, provide keying schedule listing levels of keying as well as explanation of key system's function, key symbols used and door numbers controlled.
    - b. Use ANSI A156.28 "Recommended Practices for Keying Systems" as guideline for nomenclature, definitions, and approach for selecting optimal keying system.
    - c. Provide 3 copies of keying schedule for review prepared and detailed in accordance with referenced DHI publication. Include schematic keying diagram and index each key to unique door designations.
    - d. Index keying schedule by door number, keyset, hardware heading number, cross keying instructions, and special key stamping instructions.
    - e. Provide one complete bitting list of key cuts and one key system schematic illustrating system usage and expansion.
      - 1) Forward bitting list, key cuts and key system schematic directly to Owner, by means as directed by Owner.
    - f. Prepare key schedule by or under supervision of supplier, detailing Owner's final keying instructions for locks.
  - 5. Templates: After final approval of hardware schedule, provide templates for doors, frames and other work specified to be factory prepared for door hardware installation.
- C. Informational Submittals:
- 1. Qualification Data: For Supplier, Installer and Architectural Hardware Consultant.
  - 2. Product Certificates for electrified door hardware, signed by manufacturer:
    - a. Certify that door hardware approved for use on types and sizes of labeled fire-rated doors complies with listed fire-rated door assemblies.
  - 3. Certificates of Compliance:
    - a. Certificates of compliance for fire-rated hardware and installation instructions if requested by Architect or Authority Having Jurisdiction.
    - b. Installer Training Meeting Certification: Letter of compliance, signed by Contractor, attesting to completion of installer training meeting specified in "QUALITY ASSURANCE" article, herein.
    - c. Electrified Hardware Coordination Conference Certification: Letter of compliance, signed by Contractor, attesting to completion of electrified hardware coordination conference, specified in "QUALITY ASSURANCE" article, herein.
  - 4. Product Test Reports: For compliance with accessibility requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by qualified testing agency, for door hardware on doors located in accessible routes.

5. Warranty: Special warranty specified in this Section.

D. Closeout Submittals:

1. Operations and Maintenance Data : Provide in accordance with Division 01 and include:
  - a. Complete information on care, maintenance, and adjustment; data on repair and replacement parts, and information on preservation of finishes.
  - b. Catalog pages for each product.
  - c. Name, address, and phone number of local representative for each manufacturer.
  - d. Parts list for each product.
  - e. Final approved hardware schedule, edited to reflect conditions as-installed.
  - f. Final keying schedule
  - g. Copies of floor plans with keying nomenclature
  - h. Copy of warranties including appropriate reference numbers for manufacturers to identify project.

1.5 QUALITY ASSURANCE

A. Product Substitutions: Comply with product requirements stated in Division 01 and as specified herein.

1. Where specific manufacturer's product is named and accompanied by "No Substitute," including make or model number or other designation, provide product specified. (Note: Certain products have been selected for their unique characteristics and particular project suitability.)
  - a. Where no additional products or manufacturers are listed in product category, requirements for "No Substitute" govern product selection.
2. Where products indicate "acceptable substitute" or "acceptable manufacturer", provide product from specified manufacturers, subject to compliance with specified requirements and "Single Source Responsibility" requirements stated herein.

B. Supplier Qualifications and Responsibilities: Recognized architectural hardware supplier with record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that provides certified Architectural Hardware Consultant (AHC) available to Owner, Architect, and Contractor, at reasonable times during the Work for consultation.

1. Warehousing Facilities: In Project's vicinity.
2. Scheduling Responsibility: Preparation of door hardware and keying schedules.
3. Engineering Responsibility: Preparation of data for electrified door hardware, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.



4. Coordination Responsibility: Coordinate installation of electronic security hardware with Architect and electrical engineers and provide installation and technical data to Architect and other related subcontractors.
  - a. Upon completion of electronic security hardware installation, inspect and verify that all components are working properly.
- C. Installer Qualifications: Qualified tradesmen, skilled in application of commercial grade hardware with record of successful in-service performance for installing door hardware similar in quantity, type, and quality to that indicated for this Project.
- D. Architectural Hardware Consultant Qualifications: Person who is experienced in providing consulting services for door hardware installations that are comparable in material, design, and extent to that indicated for this Project and meets these requirements:
  1. For door hardware, DHI-certified, Architectural Hardware Consultant (AHC.)
  2. Can provide installation and technical data to Architect and other related subcontractors.
  3. Can inspect and verify components are in working order upon completion of installation.
  4. Capable of producing wiring diagrams.
  5. Capable of coordinating installation of electrified hardware with Architect and electrical engineers.
- E. Single Source Responsibility: Obtain each type of door hardware from single manufacturer.
  1. Provide electrified door hardware from same manufacturer as mechanical door hardware, unless otherwise indicated.
  2. Manufacturers that perform electrical modifications and that are listed by testing and inspecting agency acceptable to authorities having jurisdiction are acceptable.
- F. Means of Egress Doors: Latches do not require more than 15 lbf (67 N) to release latch. Locks do not require use of key, tool, or special knowledge for operation.
- G. Accessibility Requirements: For door hardware on doors in an accessible route, comply with governing accessibility regulations cited in "REFERENCES" article, herein.
  1. Provide operating devices that do not require tight grasping, pinching, or twisting of wrist and that operate with force of not more than 5 lbf (22.2 N.)
  2. Maximum opening-force requirements:
    - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
    - b. Sliding or Folding Doors: 5 lbf (22.2 N) applied parallel to door at latch.
    - c. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.

3. Bevel raised thresholds with slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
  4. Adjust door closer sweep periods so that, from open position of 70 degrees, door will take at least 3 seconds to move to 3 inches (75 mm) from latch, measured to leading edge of door.
- H. Pre-installation Conference: Conduct conference at Project site
1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  2. Inspect and discuss preparatory work performed by other trades.
  3. Inspect and discuss electrical roughing-in for electrified door hardware.
  4. Review sequence of operation for each type of electrified door hardware.
  5. Review required testing, inspecting, and certifying procedures.
- I. Coordination Conferences:
1. Installation Coordination Conference: Prior to hardware installation, schedule and hold meeting to review questions or concerns related to proper installation and adjustment of door hardware.
    - a. Attendees: Door hardware supplier, door hardware installer, Contractor.
    - b. After meeting, provide letter of compliance to Architect, indicating when meeting was held and who was in attendance.
- 1.6 DELIVERY, STORAGE, AND HANDLING
- A. Inventory door hardware on receipt and provide secure lock-up for hardware delivered to Project site.
- B. Tag each item or package separately with identification coordinated with final door hardware schedule, and include installation instructions, templates, and necessary fasteners with each item or package.
1. Deliver each article of hardware in manufacturer's original packaging.
- C. Project Conditions:
1. Maintain manufacturer-recommended environmental conditions throughout storage and installation periods.
  2. Provide secure lock-up for door hardware delivered to Project, but not yet installed. Control handling and installation of hardware items so that completion of Work will not be delayed by hardware losses both before and after installation.
- D. Protection and Damage:
1. Promptly replace products damaged during shipping.
  2. Handle hardware in manner to avoid damage, marring, or scratching. Correct, replace or repair products damaged during Work.

3. Protect products against malfunction due to paint, solvent, cleanser, or any chemical agent.
- E. Deliver keys to manufacturer of key control system for subsequent delivery to Owner.
- F. Deliver keys and permanent cores (if applicable) to Owner by registered mail or overnight package service.

#### 1.7 COORDINATION

- A. Coordinate layout and installation of floor-recessed door hardware with floor construction. Cast anchoring inserts into concrete. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Installation Templates: Distribute for doors, frames, and other work specified to be factory prepared. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.
- C. Direct shipments not permitted, unless approved by Contractor.

#### 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
  1. Warranty Period: Years from date of Substantial Completion, for durations indicated.
    - a. Closers:
      - 1) Mechanical: 30 years for surface closers and 15 years for concealed closers
    - b. Exit Devices:
      - 1) Mechanical: 3 years.
    - c. Locksets:
      - 1) Mechanical: 3 years.
    - d. Continuous Hinges: Lifetime warranty.
    - e. Key Blanks: Lifetime
  2. Warranty does not cover damage or faulty operation due to improper installation, improper use or abuse.

#### 1.9 MAINTENANCE

- A. Maintenance Tools:
  1. Furnish complete set of special tools required for maintenance and adjustment of hardware, including changing of cylinders.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Approval of manufacturers other than those listed shall be in accordance with QUALITY ASSURANCE article, herein.
- B. Hand of Door: Drawings show direction of slide, swing, or hand of each door leaf. Furnish each item of hardware for proper installation and operation of door movement as shown.
- C. Where specified hardware is not adaptable to finished shape or size of members requiring hardware, furnish suitable types having same operation and quality as type specified, subject to Architect's approval.

### 2.2 MATERIALS

- A. Fasteners
  - 1. Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation.
  - 2. Furnish screws for installation with each hardware item. Finish exposed (exposed under any condition) screws to match hardware finish, or, if exposed in surfaces of other work, to match finish of this other work including prepared for paint surfaces to receive painted finish.
  - 3. Provide concealed fasteners for hardware units exposed when door is closed except when no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless thru-bolts are required to fasten hardware securely. Review door specification and advise Architect if thru-bolts are required.
  - 4. Install hardware with fasteners provided by hardware manufacturer.
- B. Provide screws, bolts, expansion shields, drop plates and other devices necessary for hardware installation.
  - 1. Where fasteners are exposed to view: Finish to match adjacent door hardware material.

### 2.3 KEYING

- A. Keying Requirements – General
  - 1. Permanent cylinders/cores keyed by the manufacturer according to the following key system.
    - a. Keying system tied into existing system as directed by the Owner.

2. Forward bitting list and keys separately from cylinders, by means as directed by Owner. Failure to comply with forwarding requirements shall be cause for replacement of cylinders/cores involved at no additional cost to Owner.

B. Keys

1. Material: Nickel silver; minimum thickness of .092-inch (2.3mm.)
2. Quantity: Furnish in the following quantities.
  - a. Change (Day) Keys: 3 per cylinder/core.
  - b. Permanent Control Keys: 3.
  - c. Master Keys: 6.
  - d. Unused balance of key blanks shall be furnished to Owner with the cut keys.

2.4 FINSHES

- A. Finish: BHMA 613 (US10B); except:
1. Door Closers: Powder Coat to Match.
  2. Thresholds: Mill Finish Aluminum.

2.5 ELECTRIC STRIKES

- A. Electric Strikes: BHMA A156.31; Grade 1; with faceplate to suit lock and frame.
- B. Manufacturer and Product: Von Duprin 6100 Series
- C. Strikes shall be suitable for electrified removable mullion.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Prior to installation of hardware, examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire-rated door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights to comply with the following, unless otherwise indicated or required to comply with governing regulations.
1. Standard Aluminum Doors and Frames: ANSI/SDI A250.8.

- B. Install each hardware item in compliance with manufacturer's instructions and recommendations, using only fasteners provided by manufacturer.
- C. Do not install surface mounted items until finishes have been completed on substrate. Protect all installed hardware during painting.
- D. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate as necessary for proper installation and operation.
- E. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
- F. Install operating parts so they move freely and smoothly without binding, sticking, or excessive clearance.
- G. Hinges: Install types and in quantities indicated in door hardware schedule but not fewer than quantity recommended by manufacturer for application indicated or one hinge for every 30 inches (750 mm) of door height, whichever is more stringent, unless other equivalent means of support for door, such as spring hinges or pivots, are provided.
- H. Lock Cylinders: Install construction cores to secure building and areas during construction period.
  - 1. Replace construction cores with permanent cores as indicated in keying section.
  - 2. Furnish permanent cores to Owner for installation (if applicable.)
- I. Door Closers: Mount closers on room side of corridor doors, inside of exterior doors, and stair side of stairway doors from corridors. Closers shall not be visible in corridors, lobbies and other public spaces unless approved by Architect.
- J. Closer/Holders: Mount closer/holders on room side of corridor doors, inside of exterior doors, and stair side of stairway doors.
- K. Thresholds: Set thresholds in full bed of sealant complying with requirements specified in Division 07 Section "Joint Sealants."
- L. Stops: Provide floor stops for doors unless wall or other type stops are indicated in door hardware schedule. Do not mount floor stops where they may impede traffic or present tripping hazard.
- M. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.

### 3.3 FIELD QUALITY CONTROL

- A. Architectural Hardware Consultant: Engage qualified independent Architectural Hardware Consultant to perform inspections and to prepare inspection reports.

1. Architectural Hardware Consultant will inspect door hardware and state in each report whether installed work complies with or deviates from requirements, including whether door hardware is properly installed and adjusted.

### 3.4 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.
  1. Door Closers: Adjust sweep period to comply with accessibility requirements and requirements of authorities having jurisdiction.

### 3.5 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of Substantial Completion.

### 3.6 DEMONSTRATION

- A. Provide training for Owner's maintenance personnel to adjust, operate, and maintain door hardware and door hardware finishes. Refer to Division 01 Section "Demonstration and Training."

### 3.7 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. | MK - McKinney            |
| 2. | RO - Rockwood            |
| 3. | SA - Sargent             |
| 4. | BE - Best Access Systems |
| 5. | RF - Rixson              |

|     |                    |
|-----|--------------------|
| 6.  | NO - Norton        |
| 7.  | PE - Pemko         |
| 8.  | SU – Securitron    |
| 9.  | LCN – LCN Products |
| 10. | VON – Von Duprin   |
| 11. | SC - Schlage       |
| 12. | FA - Falcon        |
| 13. | IV - Ives          |
| 14. | AG - Allegion      |

C. Hardware Sets:

| <b>HW1 – DOUBLE VESTIBULE DOOR (VISITORS)</b> |                           |   |       |     |
|---|---------------------------|---|-------|-----|
| 1   | CONTINUOUS HINGE          | 112HD                                     | CL    | IV  |
| 1   | CONTINUOUS HINGE          | 112HD EPT                                 | CL    | IV  |
| 1   | EXIT DEVICE               | CD-DL-25-R-NL-EO<br>W/ STRIKES            | US26D | FA  |
| 1   | EXIT DEVICE               | MEL-DL-25-R-NL-OP<br>W/ STRIKES           | US26D | FA  |
| 1   | REMOVABLE<br>MULLION      | 2923                                      | CL    | FA  |
| 1   | PERMANENT CORE            | COMPATIBLE WITH<br>EXISTING KEY<br>SYSTEM | 626   | BE  |
| 1   | ELECTRIC STRIKE           | 6300XFSEX24VDC                            | US26D | FA  |
| 2   | DOOR PULL                 | 8190HD X 10"                              | US26D | IV  |
| 2   | SURFACE CLOSER            | 4050 EDA AL                               | AL    | LCN |
| 2   | DOOR SILENCER             | SR64-1                                    | GRY   | IV  |
| 2   | GASKETING                 | S773BL                                    |       | PE  |
| 2   | ASTRAGAL                  | S772BL                                    |       | PE  |
| 6   | FILLER PLATE              | SIZE AS REQUIRED                          |       | RO  |
| 1   | WIRING HARNESS -<br>FRAME | QC-C1500                                  |       | MK  |
| 1   | WIRING HARNESS -<br>DOOR  | QC-CXXX (SIZE AS<br>REQUIRED)             |       | MK  |
| 1   | WIRING DIAGRAM            | WD-SYSPK                                  |       | SA  |
| 1   | ACCESS CONTROL            | MANUALLY<br>ACTIVATED –<br>COORDINATE W/  |       | -   |



|  |                           |  |       |     |
|--|---------------------------|--|-------|-----|
|  |                           | VENDOR   |       |     |
| 1  | POWER SUPPLY              | PS902 X 900 - BBK                                    |       | VON |
| 1  | POWER TRANSFER            | EPT-10   | SP28  | VON |
| <u>OPERATION DESCRIPTION:</u>  |                           |  |       |     |
| - DOORS TYPICALLY CLOSED AND LOCKED.   |                           |  |       |     |
| - ENTRY FROM EXTERIOR SIDE TRIGGERED VIA SECURITY ACTIVATED DOOR RELEASE AFTER CLEARANCE THROUGH BUILDING SECURITY SYSTEM. |                           |  |       |     |
| - FREE EGRESS OF EACH DOOR INDIVIDUALLY USING EXIT DEVICE FROM INTERIOR SIDE.  |                           |  |       |     |
| <b>HW2 – DOUBLE VESTIBULE DOOR (STAFF &amp; STUDENTS)</b>  |                           |  |       |     |
| 1  | CONTINUOUS HINGE          | 112HD  | CL    | IV  |
| 1  | CONTINUOUS HINGE          | 112HD EPT  | CL    | IV  |
| 1  | EXIT DEVICE               | CD-DL-25-R-NL-EO<br>W/ STRIKES                       | US26D | FA  |
| 1  | EXIT DEVICE               | MEL-DL-25-R-NL-OP<br>W/ STRIKES                      | US26D | FA  |
| 1  | REMOVABLE<br>MULLION      | 2923 W/ STRIKES                                      | CL    | FA  |
| 1  | PERMANENT CORE            | COMPATIBLE WITH<br>EXISTING KEY<br>SYSTEM            | 626   | BE  |
| 1  | ELECTRIC STRIKE           | 6300XFSEX24VDC                                       | US26D | FA  |
| 2  | DOOR PULL                 | 8190HD X 10"   | US26D | IV  |
| 2  | SURFACE CLOSER            | 4050 EDA AL  | AL    | LCN |
| 2  | DOOR SILENCER             | SR64-1   | GRY   | IV  |
| 2  | GASKETING                 | S773BL   |       | PE  |
| 2  | ASTRAGAL                  | S772BL   |       | PE  |
| 6  | FILLER PLATE              | SIZE AS REQUIRED                                     |       | RO  |
| 1  | WIRING HARNESS -<br>FRAME | QC-C1500   |       | MK  |
| 1  | WIRING HARNESS -<br>DOOR  | QC-CXXX (SIZE AS<br>REQUIRED)                        |       | MK  |
| 1  | WIRING DIAGRAM            | WD-SYSPK   |       | SA  |
| 1  | ACCESS CONTROL            | CREDENTIAL<br>ACTIVATED –<br>COORDINATE W/<br>VENDOR |       | -   |

|   |                |                   |      |     |
|---|----------------|-------------------|------|-----|
| 1 | POWER SUPPLY   | PS902 X 900 - BBK |      | VON |
| 1 | POWER TRANSFER | EPT-10            | SP28 | VON |

OPERATION DESCRIPTION:

- DOORS TYPICALLY CLOSED AND LOCKED.
- ENTRY FROM EXTERIOR SIDE TRIGGERED VIA LOCALIZED DOOR RELEASE UPON PRESENTATION OF ACCEPTABLE CREDENTIALS BY USER.
- FREE EGRESS OF EACH DOOR INDIVIDUALLY USING EXIT DEVICE FROM INTERIOR SIDE.

**HW3 – DOUBLE VESTIBULE DOOR (EGRESS ONLY)**

|   |                      |   |       |     |
|---|----------------------|---|-------|-----|
| 2 | CONTINUOUS HINGE     | 112HD                                     | CL    | IV  |
| 2 | EXIT DEVICE          | CD-DL-25-R-NL-EO<br>W/ STRIKES            | US26D | FA  |
| 1 | REMOVABLE<br>MULLION | 2923 W/ STRIKES                           | CL    | FA  |
| 2 | PERMANENT CORE       | COMPATIBLE WITH<br>EXISTING KEY<br>SYSTEM | 626   | BE  |
| 2 | DOOR PULL            | 8190HD X 10"                              | US26D | IV  |
| 2 | SURFACE CLOSER       | 4050 EDA AL                               | AL    | LCN |
| 2 | DOOR SILENCER        | SR64-1                                    | GRY   | IV  |
| 2 | GASKETING            | <a href="#">S773BL</a>                    |       | PE  |
| 2 | ASTRAGAL             | S772BL                                    |       | PE  |
| 6 | FILLER PLATE         | <a href="#">SIZE AS REQUIRED</a>          |       | RO  |

OPERATION DESCRIPTION:

- DOORS TYPICALLY CLOSED AND LOCKED.
- FREE EGRESS OF EACH DOOR INDIVIDUALLY USING EXIT DEVICE FROM INTERIOR SIDE.

**HW4 – SINGLE VESTIBULE DOOR (VISITORS)**

|   |                  |   |       |     |
|---|------------------|---|-------|-----|
| 1 | CONTINUOUS HINGE | 112HD EPT                                 | CL    | IV  |
| 1 | INTRUDER LOCK    | <a href="#">72 8238 LNB</a>               | US26D | SA  |
| 1 | PERMANENT CORE   | COMPATIBLE WITH<br>EXISTING KEY<br>SYSTEM | 626   | BE  |
| 1 | ELECTRIC STRIKE  | 6300XFSEX24VDC                            | US26D | FA  |
| 1 | SURFACE CLOSER   | 4050 EDA AL                               | AL    | LCN |
| 1 | DOOR SILENCER    | SR64-1                                    | GRY   | IV  |
| 1 | GASKETING        | <a href="#">S773BL</a>                    |       | PE  |

|   |                           |  |      |     |
|---|---------------------------|--|------|-----|
| 1 | ASTRAGAL                  | S772BL   |      | PE  |
| 3 | FILLER PLATE              | SIZE AS REQUIRED                                   |      | RO  |
| 1 | WIRING HARNESS -<br>FRAME | QC-C1500   |      | MK  |
| 1 | WIRING HARNESS -<br>DOOR  | QC-CXXX (SIZE AS<br>REQUIRED)                      |      | MK  |
| 1 | WIRING DIAGRAM            | WD-SYSPK   |      | SA  |
| 1 | ACCESS CONTROL            | MANUALLY<br>ACTIVATED –<br>COORDINATE W/<br>VENDOR |      | -   |
| 1 | POWER SUPPLY              | PS902 X 900 - BBK                                  |      | VON |
| 1 | POWER TRANSFER            | EPT-10   | SP28 | VON |

**OPERATION DESCRIPTION:**

- DOORS TYPICALLY CLOSED AND LOCKED.
- ENTRY FROM EXTERIOR SIDE TRIGGERED VIA SECURITY ACTIVATED DOOR RELEASE AFTER CLEARANCE THROUGH BUILDING SECURITY SYSTEM.
- FREE EGRESS OF EACH DOOR USING EXIT DEVICE FROM INTERIOR SIDE, UNLESS OVERRIDDEN BY SECURITY CONTROL SYSTEM.

**HW5 – SINGLE SECURITY ROOM DOOR**

|   |                  |   |       |    |
|---|------------------|---|-------|----|
| 1 | CONTINUOUS HINGE | MCK-25HD                                  | CL    | MK |
| 1 | INTRUDER LOCK    | 72 8238 LNB                               | US26D | SA |
| 1 | PERMANENT CORE   | COMPATIBLE WITH<br>EXISTING KEY<br>SYSTEM | 626   | BE |
| 1 | DOOR CLOSER      | 7500 / P7500                              | 689   | NO |
| 1 | KICK PLATE       | K1050 10" HIGH BEV<br>CSK                 | US32D | RO |
| 1 | DOOR STOP        | 400 / 441CU                               | US26D | RO |
| 1 | GASKETING        | S773BL                                    |       | PE |
| 1 | ASTRAGAL         | S772BL                                    |       | PE |
| 3 | FILLER PLATE     | SIZE AS REQUIRED                          |       | RO |

**HW6 – SINGLE MAIN OFFICE DOOR**

|   |                  |             |      |    |
|---|------------------|-------------|------|----|
| 1 | CONTINUOUS HINGE | MCK-25HD    | CL   | MK |
| 1 | CLASSROOM LOCK   | 72 8237 LNB | US15 | SA |

|  |                  |   |       |     |
|--|------------------|---|-------|-----|
| 1  | PERMANENT CORE   | COMPATIBLE WITH<br>EXISTING KEY<br>SYSTEM | 626   | BE  |
| 1  | DOOR CLOSER      | 7500 / P7500                              | 689   | NO  |
| 1  | KICK PLATE       | K1050 10" HIGH BEV<br>CSK                 | US32D | RO  |
| 1  | DOOR STOP        | 400 / 441CU                               | US26D | RO  |
| 1  | GASKETING        | S773BL                                    |       | PE  |
| 1  | ASTRAGAL         | S772BL                                    |       | PE  |
| 3  | FILLER PLATE     | SIZE AS REQUIRED                          |       | RO  |
| <b>HW7 – SINGLE MAIN OFFICE DOOR (TO CORRIDOR)</b> |                  |   |       |     |
| 1  | CONTINUOUS HINGE | 112HD                                     | CL    | IV  |
| 1  | EXIT DEVICE      | CD-DL-F-25-C-NL-EO<br>W/ STRIKES          | US26D | FA  |
| 1  | LEVER TRIM       | 712L-M                                    | US26D | FA  |
| 2  | PERMANENT CORE   | COMPATIBLE WITH<br>EXISTING KEY<br>SYSTEM | 626   | BE  |
| 1  | DOOR CLOSER      | 7500 / P7500                              | 689   | NO  |
| 1  | KICK PLATE       | K1050 10" HIGH BEV<br>CSK                 | US32D | RO  |
| 1  | DOOR STOP        | 400 / 441CU                               | US26D | RO  |
| 1  | GASKETING        | S773BL                                    |       | PE  |
| 1  | ASTRAGAL         | S772BL                                    |       | PE  |
| 3  | FILLER PLATE     | SIZE AS REQUIRED                          |       | RO  |
| <b>HW8 – DOUBLE INTERIOR STAIR DOOR (EGRESS)</b>   |                  |   |       |     |
| 2  | CONTINUOUS HINGE | 112HD                                     | CL    | IV  |
| 2  | EXIT DEVICE      | CD-DL-F-25-V-NL-EO<br>W/ STRIKES          | US26D | FA  |
| 2  | PERMANENT CORE   | COMPATIBLE WITH<br>EXISTING KEY<br>SYSTEM | 626   | BE  |
| 2  | DOOR PULL        | 8190HD X 10"                              | US26D | IV  |
| 2  | SURFACE CLOSER   | 4050 EDA AL                               | AL    | LCN |
| 2  | DOOR SILENCER    | SR64-1                                    | GRY   | IV  |

|   |                                |   |       |    |
|---|--------------------------------|---|-------|----|
| 2   | GASKETING                      | S773BL                                    |       | PE |
| 2   | ASTRAGAL                       | S772BL                                    |       | PE |
| 6   | FILLER PLATE                   | SIZE AS REQUIRED                          |       | RO |
| <b>HW9 – SINGLE OFFICE DOOR (PRIVATE)</b>         |                                |   |       |    |
| 1   | CONTINUOUS HINGE               | MCK-25HD                                  | CL    | MK |
| 1   | OFFICE LOCK                    | 72 8256 LNB                               | US26D | SA |
| 1   | PERMANENT CORE                 | COMPATIBLE WITH<br>EXISTING KEY<br>SYSTEM | 626   | BE |
| 1   | DOOR CLOSER                    | 7500 / P7500                              | 689   | NO |
| 1   | KICK PLATE                     | K1050 10" HIGH BEV<br>CSK                 | US32D | RO |
| 1   | DOOR STOP                      | 400 / 441CU                               | US26D | RO |
| 1   | GASKETING                      | S773BL                                    |       | PE |
| 1   | ASTRAGAL                       | S772BL                                    |       | PE |
| 3   | FILLER PLATE                   | SIZE AS REQUIRED                          |       | RO |
| <b>HW10 – SINGLE OFFICE DOOR (PASS-THRU)</b>      |                                |   |       |    |
| 1   | CONTINUOUS HINGE               | MCK-25HD                                  | CL    | MK |
| 1   | ENTRY LOCK                     | 72 8205 LNB                               | US26D | SA |
| 1   | PERMANENT CORE                 | COMPATIBLE WITH<br>EXISTING KEY<br>SYSTEM | 626   | BE |
| 1   | DOOR CLOSER                    | 7500 / P7500                              | 689   | NO |
| 1   | KICK PLATE                     | K1050 10" HIGH BEV<br>CSK                 | US32D | RO |
| 1   | DOOR STOP                      | 400 / 441CU                               | US26D | RO |
| 1   | GASKETING                      | S773BL                                    |       | PE |
| 1   | ASTRAGAL                       | S772BL                                    |       | PE |
| 3   | FILLER PLATE                   | SIZE AS REQUIRED                          |       | RO |
| <b>HW11 – SINGLE STUDENT USE TOILET ROOM DOOR</b> |                                |   |       |    |
| 1   | CONTINUOUS HINGE               | MCK-25HD                                  | CL    | MK |
| 1   | PRIVACY LOCK (W/<br>INDICATOR) | 49 72 8265 LNB                            | US26D | SA |
| 1   | PERMANENT CORE                 | COMPATIBLE WITH                           | 626   | BE |

|  |                         |                                     |       |    |
|--|-------------------------|-------------------------------------|-------|----|
|  |                         | EXISTING KEY SYSTEM                 |       |    |
| 1  | DOOR CLOSER             | 7500 / P7500                        | 689   | NO |
| 1  | KICK PLATE              | K1050 10" HIGH BEV CSK              | US32D | RO |
| 1  | DOOR STOP               | 400 / 441CU                         | US26D | RO |
| 1  | GASKETING               | S773BL                              |       | PE |
| 1  | ASTRAGAL                | S772BL                              |       | PE |
| 3  | FILLER PLATE            | SIZE AS REQUIRED                    |       | RO |
| <b>HW12 – SINGLE PUBLIC USE TOILET ROOM DOOR</b> |                         |                                     |       |    |
| 1  | CONTINUOUS HINGE        | MCK-25HD                            | CL    | MK |
| 1  | PRIVACY LOCK            | 72 8265 LNB                         | US26D | SA |
| 1  | PERMANENT CORE          | COMPATIBLE WITH EXISTING KEY SYSTEM | 626   | BE |
| 1  | DOOR CLOSER             | 7500 / P7500                        | 689   | NO |
| 1  | KICK PLATE              | K1050 10" HIGH BEV CSK              | US32D | RO |
| 1  | DOOR STOP               | 400 / 441CU                         | US26D | RO |
| 1  | GASKETING               | S773BL                              |       | PE |
| 1  | ASTRAGAL                | S772BL                              |       | PE |
| 3  | FILLER PLATE            | SIZE AS REQUIRED                    |       | RO |
| <b>HW13 – SINGLE CLASSROOM SECURITY DOOR</b>     |                         |                                     |       |    |
| 1  | CONTINUOUS HINGE        | MCK-25HD                            | CL    | MK |
| 1  | CLASSROOM INTRUDER LOCK | 72 8242 LNB                         | US26D | SA |
| 1  | PERMANENT CORE          | COMPATIBLE WITH EXISTING KEY SYSTEM | 626   | BE |
| 1  | DOOR CLOSER             | 7500 / P7500                        | 689   | NO |
| 1  | KICK PLATE              | K1050 10" HIGH BEV CSK              | US32D | RO |
| 1  | DOOR STOP               | 400 / 441CU                         | US26D | RO |
| 1  | GASKETING               | S773BL                              |       | PE |
| 1  | ASTRAGAL                | S772BL                              |       | PE |

|  |                    |   |       |    |
|--|--------------------|---|-------|----|
| 3  | FILLER PLATE       | SIZE AS REQUIRED                          |       | RO |
| <b>HW14 – SINGLE CLASSROOM DOOR (PASS-THRU)</b>  |                    |   |       |    |
| 1  | CONTINUOUS HINGE   | MCK-25HD                                  | CL    | MK |
| 1  | INSTITUTIONAL LOCK | 72 8217 LNB                               | US26D | SA |
| 1  | PERMANENT CORE     | COMPATIBLE WITH<br>EXISTING KEY<br>SYSTEM | 626   | BE |
| 1  | DOOR CLOSER        | 7500 / P7500                              | 689   | NO |
| 1  | KICK PLATE         | K1050 10" HIGH BEV<br>CSK                 | US32D | RO |
| 1  | DOOR STOP          | 400 / 441CU                               | US26D | RO |
| 1  | GASKETING          | S773BL                                    |       | PE |
| 1  | ASTRAGAL           | S772BL                                    |       | PE |
| 3  | FILLER PLATE       | SIZE AS REQUIRED                          |       | RO |
| <b>HW15 – SINGLE STORAGE ROOM DOOR</b>           |                    |   |       |    |
| 1  | CONTINUOUS HINGE   | MCK-25HD                                  | CL    | MK |
| 1  | STOREROOM LOCK     | 72 8242 LNB                               | US26D | SA |
| 1  | PERMANENT CORE     | COMPATIBLE WITH<br>EXISTING KEY<br>SYSTEM | 626   | BE |
| 1  | DOOR CLOSER        | 7500 / P7500                              | 689   | NO |
| 1  | KICK PLATE         | K1050 10" HIGH BEV<br>CSK                 | US32D | RO |
| 1  | DOOR STOP          | 400 / 441CU                               | US26D | RO |
| 1  | GASKETING          | S773BL                                    |       | PE |
| 1  | ASTRAGAL           | S772BL                                    |       | PE |
| 3  | FILLER PLATE       | SIZE AS REQUIRED                          |       | RO |
| <b>HW16 – DOUBLE CORRIDOR DOOR (EGRESS ONLY)</b> |                    |   |       |    |
| 2  | CONTINUOUS HINGE   | 112HD                                     | CL    | IV |
| 2  | EXIT DEVICE        | CD-DL-F-25-V-NL-EO<br>W/ STRIKES          | US26D | FA |
| 2  | PERMANENT CORE     | COMPATIBLE WITH<br>EXISTING KEY<br>SYSTEM | 626   | BE |

|   |                           |  |       |     |
|---|---------------------------|--|-------|-----|
| 2 | DOOR PULL                 | 8190HD X 10"                                     | US26D | IV  |
| 2 | SURFACE CLOSER            | 4050 EDA AL                                      | AL    | LCN |
| 2 | DOOR SILENCER             | SR64-1   | GRY   | IV  |
| 2 | GASKETING                 | S773BL   |       | PE  |
| 2 | ASTRAGAL                  | S772BL   |       | PE  |
| 6 | FILLER PLATE              | SIZE AS REQUIRED                                 |       | RO  |
| 2 | ELECTROMAGNETIC<br>HOLDER | COMPATIBLE WITH<br>EXISTING FIRE<br>ALARM SYSTEM |       | -   |

OPERATION DESCRIPTION:

- DOORS TYPICALLY OPEN BUT DOOR HARDWARE WILL BE LOCKED.
- FREE BYPASS IN EACH DIRECTION.
- UPON ACTIVATION OF FIRE ALARM, ELECTROMAGNETIC HOLDERS SHALL DEACTIVATE, AND DOORS SHALL CLOSE COMPLETELY AND LOCK.

END OF SECTION



## SECTION 087113 - POWER DOOR OPERATORS

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Operators for swinging doors.
- B. Controllers, actuators, and safety devices.
- C. Maintenance.

#### 1.2 RELATED REQUIREMENTS

- A. Section 087100 - Door Hardware: Balance of door hardware.

#### 1.3 DEFINITIONS

- A. Activation Device: Device that sends an electrical signal to door operator to open door when actuated.
- B. Knowing Act: Consciously initiating the opening of a power-operated door using acceptable methods, including wall-mounted switches such as push plates and controlled access devices such as keypads, card readers, and key switches.

#### 1.4 REFERENCE STANDARDS

- A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum; 2020.
- B. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- C. BHMA A156.10 - Power Operated Pedestrian Doors; 2017.
- D. BHMA A156.19 - Power Assist and Low Energy Power Operated Swinging Doors; 2019.
- E. ITS (DIR) - Directory of Listed Products; Current Edition.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- H. UL (DIR) - Online Certifications Directory; Current Edition.

- I. UL 325 - Standard for Door, Drapery, Gate, Louver, and Window Operators and Systems; Current Edition, Including All Revisions.

#### 1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate power door operators with balance of door hardware and electrical work required for each affected door opening.
  1. Electrical System Roughing-in: Coordinate layout and installation of power door operators with connections to power supplies, remote activation devices, and electric door latching hardware.
- B. Preinstallation Meeting: Convene a preinstallation meeting one week prior to commencing work of this section; require attendance by affected installers.
  1. Architect.
  2. Installer's Architectural Hardware Consultant (AHC).
  3. Construction Manager

#### 1.6 SUBMITTALS

- A. See Section 013000 - Administrative Requirements for submittal procedures.
- B. Shop Drawings:
  1. Indicate layout and dimensions; head, jamb, and sill conditions; elevations; components, anchorage, recesses, materials, and finishes, electrical characteristics and connection requirements.
  2. Identify installation tolerances required, assembly conditions, routing of service lines and conduit, and locations of operating components and boxes.
- C. Product Data: Provide data on system components, sizes, features, and finishes.
- D. Manufacturer's Installation Instructions: Indicate special procedures, perimeter conditions requiring special attention, and manufacturer's hardware and component templates.
- E. Manufacturer's qualification statement.
- F. Installer's qualification statement.
- G. Project Record Documents: Record actual locations of concealed equipment, services, and conduit.
- H. Maintenance Data: Include manufacturer's parts list and maintenance instructions for each type of hardware and operating component.
- I. Specimen warranty.

- J. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. Wrenches and other tools required for maintenance of equipment.

## 1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.
- B. Installer Qualifications: Company specializing in performing work of the type specified and with at least three years documented experience and approved by manufacturer.

## 1.8 WARRANTY

- A. See Section 017800 - Closeout Submittals for additional warranty requirements.
- B. Manufacturer Warranty: Provide 2-year manufacturer warranty for components of power door operators. Complete forms in Owner's name and register with manufacturer.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Operators for Swinging Doors:
  - 1. ASSA ABLOY Entrance Solutions: [www.besam-usa.com/#sle](http://www.besam-usa.com/#sle).
  - 2. DORMA USA, Inc: [www.dorma.com/#sle](http://www.dorma.com/#sle).
  - 3. LCN, an Allegion brand: [www.allegion.com/us/#sle](http://www.allegion.com/us/#sle).
  - 4. Horton Automatics: [www.hortondoors.com/#sle](http://www.hortondoors.com/#sle).
  - 5. NABCO Entrances Inc: [www.nabcoentrances.com/#sle](http://www.nabcoentrances.com/#sle).
  - 6. Stanley Access Technologies: [www.stanleyaccess.com/#sle](http://www.stanleyaccess.com/#sle).
  - 7. Substitutions: See Section 016000 - Product Requirements.

### 2.2 POWER DOOR OPERATORS - General

- A. Electrically Operated or Controlled Hardware: Provide necessary power supplies, relays, and interfaces as required for proper operation; provide wiring between control components and to building power connection in compliance with NFPA 70.
- B. Comply with ADA Standards for egress requirements.
- C. Comply with NFPA 101 and requirements of authorities having jurisdiction; provide units selected for actual door weight and for light pedestrian traffic unless otherwise indicated.

- D. Exterior and Vestibule Doors: Provide equipment suitable for ambient operating temperature range of minus 20 to plus 140 degrees F.
- E. Exterior Doors: Provide units capable of operating, closing, and holding doors closed under positive and negative differential pressure; if necessary, provide power closing.
- F. System Integration: Integrate operator functionality with other systems as required for a complete working installation.
  - 1. Provide time delay relay to signal automatic door operator to activate only after electric lock system is released.
  - 2. Provide fire alarm interface configurable to safely open or close doors on signal from fire alarm system.
  - 3. Provide controller output signals at the door closed or door open positions to facilitate interaction with security and access control systems.

## 2.3 OPERATORS FOR SWINGING DOORS

- A. Door Operator: Hydraulic
  - 1. Applications: Include operators for single and double doors.
  - 2. Hydraulic Operators: 3/16 hp minimum, self-contained, electrically driven.
  - 3. Speed Control: Variable, field-adjustable opening and closing cycles.
  - 4. Functionality: Full-power open, power close operation.
    - a. Full-Power Operators: Comply with BHMA A156.10; safeties required.
      - 1) Comply with UL 325; acceptable evidence of compliance includes UL (DIR) or ITS (DIR) listing or test report by testing agency acceptable to authorities having jurisdiction.
  - 5. Mounting: Surface mounted overhead.
  - 6. Components:
    - a. Header Case: Manufacturer's standard extruded aluminum profile containing door operator and door mounting components.
    - b. Motor and Gearbox Assembly: Manufacturer's standard sealed motor, gearbox, and drive belt.
  - 7. Power Supply Units: Self-contained, electrically operated, and independent of door operator.
  - 8. Actuators: Manufacturer's standard.
    - a. Actuators and Safeties: As indicated on drawings.

## 2.4 CONTROLLERS, ACTUATORS, AND SAFETY DEVICES

- A. Controllers: Manufacturer's standard for products specified.
  - 1. Provide microprocessor operated controller for each door.
- B. Actuators: Manufacturer's standard for products specified and as specified below.
  - 1. Comply with BHMA A156.10 for actuator and safety types and zones.

2. Push Plate Actuator: Standard, wall mounted, surface mounted, momentary contact type; satin stainless steel plate.
- C. Safety Devices: Manufacturer's standard units recommended for project applications and conditions.
  1. Comply with BHMA A156.10 for actuator and safety types and zones.
  2. Swinging Door Safety Device: Door-mounted proximity detector device arranged to prevent operation of door when persons or obstructions are in the swing zone.

## 2.5 ELECTRICAL CHARACTERISTICS AND COMPONENTS

- A. Electrical Characteristics:
  1. 3/16 hp.
  2. 5 rated load amperes.
  3. 120 volts, single phase, 60 Hz.
- B. Wiring Terminations: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
- C. Disconnect Switch: Factory mount disconnect switch in control panel.

## 2.6 Finishes

- A. Aluminum Finishes: Manufacturer's standard.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify installation conditions including, but not limited to the following: opening sizes, floor conditions, plumb and level mounting surfaces.
- B. Verify that surfaces are ready to receive work and dimensions are as indicated on shop drawings.
- C. Verify that electric power is available, in the correct location, and of the correct characteristics.

### 3.2 INSTALLATION

- A. Coordinate installation of components with related and adjacent work.
- B. Install equipment in accordance with manufacturer's instructions.

- C. Provide for thermal expansion and contraction of door and frame units and live and dead loads that may be transmitted to operating equipment.
- D. Provide for dimensional distortion of components during operation.

### 3.3 ADJUSTING

- A. Adjust door equipment for correct function and smooth operation.

### 3.4 CLEANING

- A. Remove temporary protection, clean exposed surfaces.

### 3.5 CLOSEOUT ACTIVITIES

- A. Demonstrate to Owner's representative equipment operation, operating components, adjustment features, and lubrication requirements.

### 3.6 MAINTENANCE

- A. Provide service and maintenance of operating equipment for one year from Date of Substantial Completion, at no extra charge to Owner.

END OF SECTION

## SECTION 088000 - GLAZING

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes:
  - 1. Glass for wood doors.
  - 2. Glass for aluminum windows and storefront framing.
  - 3. Glazing sealants and accessories.

#### 1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- C. IBC: International Building Code.
- D. Interspace: Space between lites of an insulating-glass unit.

#### 1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

#### 1.5 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.
  - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 2. Review temporary protection requirements for glazing during and after installation.

## 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches (300 mm) square.
- C. Glazing Accessory Samples: For sealants and colored spacers, in 12 inch (300 mm) lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
- D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.
- E. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

## 1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturers of insulating-glass units with sputter-coated, low-E coatings.
- B. Product Certificates: For glass.
- C. Product Test Reports: For insulating glass and glazing sealants, for tests performed by a qualified testing agency.
  - 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36 month period.
- D. Preconstruction adhesion and compatibility test report.
- E. Sample Warranties: For special warranties.

## 1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved by coated-glass manufacturer.
- B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.



- D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

#### 1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
  - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F (4.4 deg C.)

#### 1.11 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
  - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty for Insulating Glass: Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
  - 1. Warranty Period: 10 years from date of Substantial Completion.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

1. Basis-of-Design Product: Subject to compliance with requirements, provide Vitro Architectural Glass.; products or comparable products by one of the following:
  - a. Guardian Industries Corp.; SunGuard.
  - b. Oldcastle Building Envelope™.
  - c. Viracon, Inc.
- B. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
  1. Obtain tinted glass from single source from single manufacturer.
  2. Obtain reflective-coated glass from single source from single manufacturer.
- C. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

## 2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.
- C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the 2015 IBC and ASTM E 1300.
  1. Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.
    - a. Wind Design Data: Refer to 2015 IBC Code Section 1603.1.4.
  2. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.
- D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
  1. For monolithic-glass lites, properties are based on units with lites of thickness indicated.
  2. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.

3. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K.)
4. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
5. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

## 2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
  1. GANA Publications: "Glazing Manual."
  2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
  1. Minimum Glass Thickness for Exterior Lites: 6 mm.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

## 2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.
- B. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
  1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

## 2.5 LAMINATED GLASS

- A. Laminated Glass: ASTM C 1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
  - 1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.
  - 2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
  - 3. Interlayer Color: Clear unless otherwise indicated.

## 2.6 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
  - 1. Sealing System: Dual seal, with polyisobutylene and silicone primary and secondary sealants.
  - 2. Spacer: Aluminum with mill or clear anodic finish.
  - 3. Desiccant: Molecular sieve or silica gel, or a blend of both.

## 2.7 GLAZING SEALANTS

- A. General:
  - 1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
  - 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
  - 3. Field-applied sealants shall have a VOC content of not more than 250 g/L.
  - 4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Dow Corning Corporation; 790.
    - b. GE Construction Sealants; Momentive Performance Materials Inc.; SCS2700 SilPruf LM.
    - c. May National Associates, Inc.; a subsidiary of Sika Corporation; Bondaflex Sil 290.
    - d. Pecora Corporation; 890NST.

- e. Sika Corporation; SikaSil WS-290.
- f. Tremco Incorporated; Spectrem 1.

## 2.8 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
  - 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
    - a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- B. Grind smooth and polish exposed glass edges and corners.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
  - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
  - 2. Presence and functioning of weep systems.
  - 3. Minimum required face and edge clearances.
  - 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

### 3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
  - C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
  - D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
  - E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
  - F. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm.)
    - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
    - 2. Provide 1/8 inch (3 mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
  - G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
  - H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
  - I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
  - J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
  - K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.
- 3.4 GASKET GLAZING (DRY)
- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

### 3.5 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

### 3.6 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
  - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.

- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

### 3.7 LOW-E COATED INSULATED GLASS

- A. Glass Type CCL and "Insulated Glazing": Low-E-coated, clear insulating laminated glass.
  - 1. Basis-of-Design Product: Vitro Architectural Glass, Solarban 60.
  - 2. Overall Unit Thickness: 1 inch.
  - 3. Outdoor Lite: Low-E-coated, clear laminated glass with two plies of heat-strengthened float glass.
    - a. Minimum Thickness of Each Glass Ply: 3 mm.
    - b. Interlayer Thickness: 0.030 inch.
  - 4. Interspace Content: Air.
  - 5. Indoor Lite: Clear laminated glass with two plies of heat-strengthened float glass.
    - a. Minimum Thickness of Each Glass Ply: 3 mm.
    - b. Interlayer Thickness: 0.030 inch (0.76 mm.)
  - 6. Low-E Coating: Sputtered on second surface.
  - 7. Winter Nighttime U-Factor: 0.29 maximum.
  - 8. Summer Daytime U-Factor: 0.27 maximum.
  - 9. Visible Light Transmittance: 70 percent minimum.
  - 10. Solar Heat Gain Coefficient: 0.37 maximum.

### 3.8 LAMINATED GLASS SCHEDULE

- A. Glass Type LM and "Laminated Glazing": Clear laminated glass.
  - 1. Heat-Treated Laminated-Glass Units, Type 1
  - 2. Consisting of two lites of fully tempered float glass.
  - 3. Outer Lite: Clear laminated glass with two plies of heat-strengthened float glass.
    - a. Fully Tempered Glass.
    - b. Minimum Thickness of Each Glass Ply: 3 mm.
  - 4. Inner Lite: Clear laminated glass with two plies of heat-strengthened float glass.
    - a. Fully Tempered Glass.
    - b. Minimum Thickness of Each Glass Ply: 3 mm.
  - 5. Plastic Interlayer:
    - a. Interlayer: Polyvinyl butyral of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.
    - b. Interlayer Color: Clear.

### 3.9 LOW-E COATED INSULATED SAFETY GLASS SCHEDULE



- A. Glass Type ISG and "Safety Glazing": Low-E-coated, clear insulating laminated glass.
  - 1. Overall Unit Thickness: 1 inch.
  - 2. Outer Lite: Low-E-coated, clear laminated glass with two plies of heat-strengthened float glass.
    - a. 1/4 inch Fully Tempered Glass.
  - 3. Inner Lite: Clear laminated glass with two plies of heat-strengthened float glass.
    - a. 1/4 inch Fully Tempered Glass.
  - 4. Plastic Interlayer:
    - a. Interlayer: Polyvinyl butyral of thickness indicated with a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after laminating glass lites and installation.
    - b. Interlayer Color: Clear.
  - 5. Requirements:
    - a. Provide glazing that complies with 16 CFR 1201, Category II.
    - b. Permanently mark glazing with certification label of the SGCC. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
  - 6. Low-E Coating: Sputtered on second surface.
  - 7. Winter Nighttime U-Factor: 0.47 maximum.
  - 8. Summer Daytime U-Factor: 0.50 maximum.
  - 9. Visible Light Transmittance: 87 percent minimum.
  - 10. Solar Heat Gain Coefficient: 0.37 maximum.

END OF SECTION

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## SECTION 088813 - FIRE-RESISTANT GLAZING

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Fire-protection-rated glazing.

#### 1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.
- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

#### 1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Glass Samples: For each type of glass product; 12 inches (300 mm) square.
- C. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For installers and glass testing agency.
- B. Product Certificates: For each type of glass and glazing product, from manufacturer.
- C. Sample Warranties: For special warranties.

## 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.

## 1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install fire-resistant glazing until spaces are enclosed and weathertight and temporary HVAC system is operating and maintaining ambient temperature conditions at occupancy levels during the remainder of the construction period.

## 1.10 WARRANTY

- A. Manufacturer's Special Warranty on Double Glazing Units with Clear Gel Fill: Manufacturer agrees to replace units that deteriorate within specified warranty period. Deterioration of double glazing units with clear gel fill is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning glass contrary to manufacturer's written instructions. Evidence of failure is the leakage of gel fill from units, air bubbles within units, or obstruction of vision by contamination or deterioration of gel.
  - 1. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations for Glass: Obtain from single source from single manufacturer for each glass type.
- B. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

### 2.2 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; deterioration of glazing materials; or other defects in construction.

## 2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organization below unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
  - 1. GANA Publications: "Glazing Manual."
- B. Safety Glazing Labeling: Permanently mark glazing with certification label of the Safety Glazing Certification Council. Label shall indicate manufacturer's name, type of glass, glass thickness, and safety glazing standard with which glass complies. CPSC Cat. II required.

## 2.4 GLASS PRODUCTS

- A. Ultraclear Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear), with visible light transmission not less than 91 percent.
- B. Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class I (clear) unless otherwise indicated, Quality-Q3.
  - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

## 2.5 FIRE-PROTECTION-RATED GLAZING

- A. Fire-Protection-Rated Glazing: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on positive-pressure testing according to NFPA 257 or UL 9, including the hose-stream test, and shall comply with NFPA 80 and/or ASTM E119.
  - 1. Fire-protection-rated glazing required to have a fire-protection rating of 20 minutes shall be exempt from the hose-stream test.
- B. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name; test standard; whether glazing is permitted to be used in doors or openings; if permitted in openings, whether or not glazing has passed the hose-stream test; whether or not glazing meets 450 deg F (250 deg C) temperature-rise limitation; and the fire-resistance rating in minutes.

- C. Double Glazing Units with Clear Gel Fill: Double glazing units made from two lites of uncoated, fully tempered, ultraclear float glass; with a perimeter edge seal enclosing a cavity filled with optically clear, intumescent gel; and complying with 16 CFR 1201, Category II.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide SAFTI FIRST Fire Rated Glazing Solutions; SuperLite II-XL or equal.
  - 2. Glass rating based on wall or door rating.

## 2.6 GLAZING ACCESSORIES

- A. Provide glazing gaskets, glazing sealants, glazing tapes, setting blocks, spacers, edge blocks, and other glazing accessories that are compatible with glazing products and each other and are approved by testing agencies that listed and labeled fire-resistant glazing products with which products are used for applications and fire-protection ratings indicated.
- B. Glazing Sealants for Fire-Rated Glazing Products: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT. Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated.
  - 1. Sealants shall have a VOC content of 250 g/L or less.
  - 2. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- C. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
  - 1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
  - 2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

## 2.7 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

## 2.8 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with manufacturing and installation tolerances, including those for size, squareness, and offsets at corners, and for compliance with minimum required face and edge clearances.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate fire side and protected side. Label or mark units as needed so that fire side and protected side are readily identifiable. Do not use materials that leave visible marks in the completed work.

### 3.3 GLAZING, GENERAL

- A. Use methods approved by testing agencies that listed and labeled fire-resistant glazing products.
- B. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publications.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
  - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
  - 2. Provide 1/8 inch (3 mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- I. Set glass lites with proper orientation so that coatings face fire side or protected side as specified.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

### 3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.



- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

### 3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop, so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- D. Install gaskets so they protrude past face of glazing stops.

### 3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial washaway from glass.

### 3.7 CLEANING AND PROTECTION

- A. Immediately after installation, remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
  - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.

- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

### 3.8 FIRE-PROTECTION-RATED GLAZING SCHEDULE

- A. Glass Type 'FR': Fire rate, clear glass.
  - 1. 20-minute, 45-minute and 60-minute fire-protection-rated glazing with 450 deg F (250 deg C) temperature-rise limitation; double glazing units with clear gel fill.
- B. Glass Type 'FCCL': Fire rated, Low-E coated, clear insulating laminated glass.
  - 1. Overall Unit Thickness: 1 inch.
  - 2. Vision Units: Two lites with air space, as scheduled:
  - 3. Outer Lite: Fire rated glass, see Glass Type 'FR' above.
    - a. Interior Lite: Low-E-coated, clear laminated glass with two plies of heat-strengthened float glass.
      - 1) Minimum Thickness of Each Glass Ply: 3 mm.
      - a) Interlayer Thickness: 0.030 inch Low-E Coating: Sputtered on second surface.
      - 1 Air Space: Nominal 1/2 inch measured perpendicularly from surfaces of glass lites at unit's edge.

END OF SECTION

## SECTION 088853 - SECURITY GLAZING

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes security glass for the following applications:
  - 1. Doors.
  - 2. Glazed entrances.

#### 1.3 DEFINITIONS

- A. Glazing Manufacturers: Firms that produce primary glass, monolithic plastic glazing, or fabricated security glazing, as defined in referenced glazing publications.
- B. Interspace: Space between lites of air-gap security glazing or insulating security glazing.

#### 1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on security glazing, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

#### 1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 2. Review temporary protection requirements for security glazing during and after installation.

#### 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Security Glazing Samples: For each type of security glazing; 12 inches (300 mm) square.

- C. Glazing Accessory Samples: For sealants and colored spacers, in 12 inch (300 mm) lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
- D. Security Glazing Schedule: List security glazing types and thicknesses for each size opening and location. Use same designations indicated on Drawings. Indicate coordinated dimensions of security glazing and construction that receives security glazing, including clearances and glazing channel dimensions.
- E. Delegated-Design Submittal: For security glazing indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For installers, manufactures, and testing agencies.
- B. Product Certificates: For each type of product indicated, from manufacturer.
- C. Product Test Reports: For each type of security glazing, for tests performed by a qualified testing agency.
- D. Product Test Reports: For each type of glazing sealant, for tests performed by a qualified testing agency.
  - 1. Provide test reports based on testing current sealant formulations within previous 36-month period.
- E. Preconstruction adhesion and compatibility test reports.
- F. Sample Warranties: For special warranties.

#### 1.8 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs glazing installers for this Project who are certified under the National Glass Association Glazier Certification Program.
- B. Security Glazing Testing Agency Qualifications: Subject to compliance with requirements, testing agency is one of the following:
  - 1. H. P. White Laboratory, Inc.
  - 2. Underwriters Laboratories, Inc.
  - 3. Wiss, Janney, Elstner Associates, Inc.
- C. Sealant Testing Agency Qualifications: Qualified according to ASTM C1021 for testing indicated.

## 1.9 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Test each security glazing type, tape sealant, gasket, glazing accessory, and glazing-framing member for adhesion to and compatibility with elastomeric glazing sealants.
  - 1. Testing will not be required if data based on previous testing of current sealant products and glazing materials match those submitted.
  - 2. Use ASTM C1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to security glazing, tape sealants, gaskets, and glazing channel substrates.
  - 3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
  - 4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
  - 5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.

## 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Protect security glazing and glazing materials according to manufacturer's written instructions. Prevent damage from condensation, temperature changes, direct exposure to sun, or other causes.

## 1.11 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
  - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

## 1.12 WARRANTY

- A. Manufacturer's Special Warranty on Security Glass: Manufacturer agrees to replace security glass that deteriorates within specified warranty period. Deterioration of security glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning security glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced standard.

1. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations for Security Glazing: Obtain security glazing from single source from single manufacturer using the same types of lites, plies, films, interlayers, and spacers for each security glazing type indicated.
- B. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.

### 2.2 PERFORMANCE REQUIREMENTS

- A. General:
  1. Installed security glazing shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing; or other defects in construction.
  2. Installed security glazing shall withstand security-related loads and forces without damage to the glazing beyond that allowed by referenced standards.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design security glazing.
- C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the 2015 IBC and ASTM E 1300.
  1. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glazing framing members and glazing components.
  1. Temperature Change: 120 deg F ambient; 180 deg F material surfaces.
- E. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

### 2.3 SECURITY GLAZING, GENERAL

- A. Glazing Publications: Comply with published recommendations of security glazing and glazing material manufacturers and organizations below unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
  - 1. GANA Publications: "Glazing Manual."
  - 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Plastic Glazing Labeling: Identify plastic sheets with appropriate markings of applicable testing and inspecting agency, indicating compliance with required fire-test-response characteristics.
- C. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of glazing, glass thickness, and safety glazing standard with which glazing complies.
- D. Insulating Glazing Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the Insulating Glass Certification Council.
- E. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
- F. Fire-Test-Response Characteristics of Polycarbonate Sheets: As determined by testing polycarbonate sheets identical to those used in security glazing products by a qualified testing agency acceptable to authorities having jurisdiction.
  - 1. Self-ignition temperature of 650 deg F or more when tested according to ASTM D1929 on plastic sheets in thicknesses indicated for the Work.
  - 2. Smoke-Developed Index of 450 or less when tested according to ASTM E84, or smoke density of 75 or less when tested according to ASTM D2843 on plastic sheets in thicknesses indicated for the Work.
  - 3. Burning extent of 1 inch or less when tested according to ASTM D635 at a nominal thickness of 0.060 inch or thickness indicated for the Work.
- G. Thermal and Optical Performance Properties: Provide security glazing with performance properties specified, as indicated in manufacturer's published test data, based on construction products indicated and on procedures indicated below:
  - 1. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
  - 2. Solar-Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
  - 3. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

## 2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
- B. Float Glass: ASTM C1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
- C. Heat-Treated Float Glass: ASTM C1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.

## 2.5 NON-RATED SECURITY (BALLISTIC) GLAZING

- A. Glazing Type BA or "Non-Rated Ballistic Glass"
  - 1. Basis of Design Product: Subject to compliance with requirements, provide 5/16 inch Laminated Security Glass manufactured by Armoured One, or a comparable product by one of the following:
    - a. DefenseLite.
    - b. Gaffco Ballistics.
    - c. Patriot Armor.
- B. Glazing Components:
  - 1. 5/16 inch overall thickness.
    - a. Threat Side Coating: Specified Security Film.
    - b. Threat Side Glazing: Clear Glass (as required for assembly).
    - c. Interlayer: Manufacturer's Standard Security Interlayer.
    - d. Secure Side Glazing: Clear Glass (as required for assembly).

## 2.6 FIRE-RATED SECURITY (BALLISTIC) GLAZING

- A. Glazing Type FRBA or "Fire-Rated Ballistic Glass"
  - 1. Basis of Design Product: Subject to compliance with requirements, provide 1 inch 60-Minute Fire-Rated Security Glass manufactured by Armoured One, or a comparable product by one of the following:
    - a. DefenseLite.
    - b. Gaffco Ballistics.
    - c. Patriot Armor.
- B. Glazing Components:
  - 1. 1 inch overall thickness.
    - a. Threat Side Coating: Specified Security Film.
    - b. Threat Side Glazing: Clear Glass (as required for assembly).
    - c. Interlayer: Manufacturer's Standard Security Interlayer.
    - d. Secure Side Glazing: Clear Glass (as required for assembly).

## 2.7 INSULATED SECURITY (BALLISTIC) GLAZING



- A. Glazing Type IBA or "Insulated Ballistic Glass"
  - 1. Basis of Design Product: Subject to compliance with requirements, provide 1 inch Insulated Security Glass Unit manufactured by Armoured One, or a comparable product by one of the following:
    - a. DefenseLite.
    - b. Gaffco Ballistics.
    - c. Patriot Armor.
- B. Glazing Components:
  - 1. 1 inch overall thickness.
    - a. Threat Side Coating: Specified Security Film.
    - b. Threat Side Glazing: Clear Glass (as required for assembly).
    - c. Air Gap: Filled with Argon Gas
    - d. Interlayer: Manufacturer's Standard Security Interlayer.
    - e. Secure Side Glazing: Clear Glass (as required for assembly).
  - 1) SECURITY FILM MATERIALS
- C. Security Glazing Film: Installed on glazing assemblies to provide impact resistance and forced/attack resistance complying with WEY-SA-C1, ANSI Z97.1 and CPSC 16 CFR 1201 Category II, ASTM E330, UL972, EN356 P4A, and GSA Level C as specified:
  - 1. Basis of Design Product: Subject to compliance with requirements, provide 23 Mil Security Film manufactured by Armoured One, or a comparable product by one of the following:
    - a. 3M United States
    - b. CJ Buffer
    - c. Gaffco Ballistics
    - d. Total Security Solutions
- D. Film Materials: Surface applied Transparent polyester film for permanent bonding to glass.
  - 1. Thickness: 0.023 inch, minimum. Must be a single layer film. Multi-layering film to achieve thickness is not acceptable.
  - 2. Color: Clear.
  - 3. Construction: 3-ply laminate.
  - 4. Adhesive Type: Pressure sensitive.
  - 5. Tensile Strength: 35,000 psi minimum.
  - 6. Breaking Strength: 640 lbs/inch.
  - 7. Elongation at Break: 230 %
  - 8. Surface Burning Characteristics: Flame spread index of 25, maximum, and smoke developed index of 450, maximum, when tested in accordance with ASTM E84 (Class A).

- E. Anchoring System: Provide supplemental anchoring system as required to meet forced entry resistance requirements.
  - 1. DOW 995 or GE SCS2000 SilPruf Structural Sealant with high impact styrene trim.
- F. Warranty: Provide 12 year manufacturer's replacement warranty to cover film against peeling, cracking, discoloration and deterioration.

## 2.8 GLAZING SEALANTS

- A. General:
  - 1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they contact, including security glazing, seals of insulating security glazing and air-gap security glazing, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
  - 2. Suitability: Comply with sealant and security glazing manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
  - 3. Field-applied sealants shall have a VOC content of not more than 250 g/L.
  - 4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Dow Corning Corporation; 790.
    - b. GE Construction Sealants; Momentive Performance Materials Inc.; SCS2700 SilPruf LM.
    - c. May National Associates, Inc.; a subsidiary of Sika Corporation; Bondaflex Sil 290.
    - d. Pecora Corporation; 890NST.
    - e. Sika Corporation; SikaSil WS-290.
    - f. Tremco Incorporated; Spectrem 1.
- C. Security Sealant: Manufacturer's standard, non-sag, tamper-resistant sealant for joints with low movement complying with ASTM C920, Grade NS, Class 12.5 or 25, Use NT, and with a Shore A hardness of at least 45 when tested according to ASTM C661.

## 2.9 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; non-staining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and security glazing manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:
  - 1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
  - 2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
  - 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
  - 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

## 2.10 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of security glazing and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by security glazing manufacturer to maintain security glazing lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit security glazing lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

## 2.11 FABRICATION OF SECURITY GLAZING

- A. Fabricate security glazing in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
- B. Grind smooth and polish exposed security glazing edges and corners.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine framing for security glazing, with Installer present, for compliance with the following:
  - 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
  - 2. Presence and functioning of weep system.
  - 3. Minimum required face or edge clearances.
  - 4. Minimum required bite.
  - 5. Effective sealing between joints of framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving security glazing immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

### 3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of security glazing, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect edges of security glazing from damage during handling and installation. Remove damaged security glazing from Project site and legally dispose of off Project site. Damaged security glazing includes units with edge or face damage or other imperfections that, when installed, could weaken security glazing and impair performance and appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications unless otherwise required by glazing unit manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by security glazing manufacturers for installing lites.
- F. Provide spacers for security glazing lites where the length plus width is larger than 50 inches (1270 mm).
  - 1. Locate spacers directly opposite each other on both inside and outside faces of security glazing. Install correct size and spacing to preserve required face clearances unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with performance requirements.
  - 2. Provide 1/8-inch (3-mm) minimum bite of spacers on glazing lites and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. Provide edge blocking where indicated or needed to prevent security glazing from moving sideways in glazing channel, as recommended in writing by security glazing manufacturer and according to requirements in referenced glazing publications.
- H. Set security glazing in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set coated security glazing with proper orientation so that coatings and films face exterior or interior as specified.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

### 3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by security glazing, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until just before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. Center security glazing in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

### 3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket securely in place between glazing unit and frame or fixed stop, so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center security glazing in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in security glazing. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center security glazing in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in security glazing. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

### 3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between security glazing and glazing stops to maintain face clearances and to prevent sealant from extruding into glazing channel and blocking weep systems. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to security glazing and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from security glazing.

### 3.7 CLEANING AND PROTECTION

- A. Immediately after installation remove non-permanent labels and clean surfaces.
- B. Protect security glazing from contact with contaminating substances resulting from construction operations, including weld splatter. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
  - 1. If, despite such protection, contaminating substances do come into contact with security glazing, remove substances immediately as recommended in writing by security glazing manufacturer. Remove and replace security glazing that cannot be cleaned without damage.
- C. Wash security glazing on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash security glazing as recommended in writing by security glazing manufacturer.

END OF SECTION

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## SECTION 089119 - FIXED LOUVERS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Fixed extruded-aluminum louvers.
  - 2. Screening for louvers.

#### 1.2 DEFINITIONS

- A. Louver Terminology: Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.
- B. Horizontal Louver: Louver with horizontal blades (i.e., the axis of the blades are horizontal).
- C. Vertical Louver: Louver with vertical blades (i.e., the axis of the blades are vertical).
- D. Drainable-Blade Louver: Louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of unit and away from opening.
- E. Wind-Driven-Rain-Resistant Louver: Louver that provides specified wind-driven-rain performance, as determined by testing in accordance with AMCA 500-L.
- F. Windborne-Debris-Impact-Resistant Louver: Louver that provides specified windborne-debris-impact resistance, as determined by testing in accordance with AMCA 540.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. For louvers specified to bear AMCA seal, include printed catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.
- B. Shop Drawings: For louvers and accessories. Include plans, elevations, sections, details, and attachments to other work. Show frame profiles and blade profiles, angles, and spacing.
  - 1. Show weep paths, gaskets, flashings, sealants, and other means of preventing water intrusion.
  - 2. Show mullion profiles and locations.

- C. Samples: For each type of metal finish required.
- D. Delegated Design Submittal: For louvers indicated to comply with structural performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Based on evaluation of comprehensive tests performed in accordance with AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.
- B. Windborne-debris-impact-resistance test reports.
- C. Sample Warranties: For manufacturer's special warranties.

#### 1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel in accordance with the following:
  - 1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
  - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."
  - 3. AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

#### 1.6 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

#### 1.7 WARRANTY

- A. Special Finish Warranty, Factory-Applied Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of baked enamel, powder coat, or organic finishes within specified warranty period.
  - 1. 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. Warranty Period: 10 years from date of Substantial Completion.

- B. Special Finish Warranty, Anodized Finishes: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of anodized finishes within specified warranty period.
  - 1. 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, peeling, or chipping.
  - 2. Warranty Period: 10 years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain fixed louvers from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, using structural performance requirements and design criteria indicated.
- B. Structural Performance: Louvers withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver-blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures are considered to act normal to the face of the building.
  - 1. Wind Loads:
    - a. Determine loads based on pressures as indicated on Drawings.
- C. Windborne-Debris-Impact Resistance: Louvers located within 30 feet of grade pass basic protection, when tested in accordance with AMCA 540.
- D. Louver Performance Ratings: Provide louvers complying with requirements specified, as demonstrated by testing manufacturer's stock units identical to those provided, except for length and width in accordance with AMCA 500-L.
- E. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.
- F. SMACNA Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

## 2.3 FIXED EXTRUDED-ALUMINUM LOUVERS

- A. Horizontal Drainable-Blade Louver, Extruded Aluminum:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide products by Ruskin Louvers and Architectural Solutions, or a comparable product by one of the following:
    - a. Aire Technologies, Inc.
    - b. Industrial Louvers, Inc.
    - c. Reliable Products
    - d. United Enertech Corp.
  - 2. Louver Depth: 4 inches minimum.
  - 3. Frame and Blade Nominal Thickness: Not less than 0.080 inch.
  - 4. Mullion Type: Exposed.
  - 5. Finish: As selected by Architect from manufacturer's full range of finishes.
  - 6. Accessories: Universal sleeves.
  - 7. Louver Performance Ratings:
    - a. Free Area: As indicated on Drawings.
    - b. Point of Beginning Water Penetration: Not less than 900 fpm.
    - c. Air Performance:
      - 1) Not more than 0.15-inch wg static pressure drop at 1000-fpm free-area velocity.
  - 8. AMCA Seal: Mark units with AMCA Certified Ratings Seal.

## 2.4 LOUVER SCREENS

- A. General: Provide screen at each exterior louver.
  - 1. Screen Location for Fixed Louvers: Interior face.
  - 2. Screening Type: Insect screening.
- B. Secure screen frames to louver frames with machine screws with heads finished to match louver, spaced a maximum of 6 inches from each corner and at 12 inches o.c.
- C. Louver Screen Frames: Fabricate with mitered corners to louver sizes indicated.
  - 1. Metal: Same type and form of metal as indicated for louver to which screens are attached. Reinforce extruded-aluminum screen frames at corners with clips.
  - 2. Finish: Same finish as louver frames to which louver screens are attached.
- D. Louver Screening for Aluminum Louvers:
  - 1. Insect Screening, Aluminum: 18-by-16 mesh, 0.012-inch wire.

## 2.5 BLANK-OFF PANELS

## 2.6 MATERIALS

- A. Aluminium Extrusions: ASTM B221, Alloy 6063-T5, T-52, or T6.
- B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming, or as otherwise recommended by metal producer for required finish.
- C. Fasteners: Use types and sizes to suit unit installation conditions.
  - 1. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.
  - 2. For fastening aluminum, use aluminum or 300 series stainless steel fasteners.
  - 3. For fastening galvanized steel, use hot-dip-galvanized-steel or 300 series stainless steel fasteners.
  - 4. For fastening stainless steel, use 300 series stainless steel fasteners.
  - 5. For color-finished louvers, use fasteners with heads that match color of louvers.
- D. Post-installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, fabricated from stainless steel components, with allowable load or strength design capacities calculated in accordance with ICC-ES AC193 and ACI 318 greater than or equal to the design load, as determined by testing in accordance with ASTM E488/E488M conducted by a qualified testing agency.

## 2.7 FABRICATION

- A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- B. Vertical Assemblies: Where height of louver units exceeds fabrication and handling limitations, fabricate units to permit field-bolted assembly with close-fitting joints in jambs and mullions, reinforced with splice plates.
  - 1. Continuous Vertical Assemblies: Fabricate units without interrupting blade-spacing pattern unless horizontal mullions are indicated.
  - 2. Horizontal Mullions: Provide horizontal mullions at joints unless continuous vertical assemblies are indicated.
- C. Maintain equal louver blade spacing to produce uniform appearance.
- D. Fabricate frames, including integral sills, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.
  - 1. Frame Type: Exterior flange, unless otherwise indicated.
- E. Include supports, anchorages, and accessories required for complete assembly.
- F. Provide vertical mullions of type and at spacings indicated, but not more than is recommended by manufacturer, or 72 inches o.c., whichever is less.

1. Exposed Mullions: Where indicated, provide units with exposed mullions of same width and depth as louver frame. Where length of louver exceeds fabrication and handling limitations, provide interlocking split mullions designed to permit expansion and contraction.
  2. Exterior Corners: Prefabricated corner units with mitered and welded blades.
- G. Provide subsills made of same material as louvers or extended sills for recessed louvers.
- H. Join frame members to each other and to fixed louver blades with fillet welds, threaded fasteners, or both, as standard with louver manufacturer, unless otherwise indicated or size of louver assembly makes bolted connections between frame members necessary.

## 2.8 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.
- B. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
1. Color: As selected by Architect from full range of industry colors and color densities.
- C. Baked-Enamel or Powder-Coat Finish: AAMA 2603. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
1. Color and Gloss: As selected by Architect from manufacturer's full range.

## PART 3 EXECUTION

### 3.1 EXAMINATION

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

### 3.2 PREPARATION

- A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.

### 3.3 INSTALLATION

- A. Locate and place louvers level, plumb, and at indicated alignment with adjacent work.

- B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.
- C. Form closely fitted joints with exposed connections accurately located and secured.
- D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.
- E. Protect unpainted galvanized- and nonferrous-metal surfaces that are in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.
- F. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses, where weathertight louver joints are required. Comply with Section 079200 "Joint Sealants" for sealants applied during louver installation.

#### 3.4 ADJUSTING AND CLEANING

- A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.
- B. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.
- C. Restore louvers damaged during installation and construction, so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Architect, remove damaged units and replace with new units.
  - 1. Touch up minor abrasions in finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

END OF SECTION

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## SECTION 090561.13 - MOISTURE VAPOR EMISSION CONTROL

### 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. Fluid-applied, resin-based, membrane-forming systems that control the moisture-vapor-emission rate of high-moisture, interior concrete to prepare it for floor covering installation.

#### 1.3 DEFINITIONS

- A. MVE: Moisture vapor emission.
- B. MVER: Moisture vapor emission rate.

#### 1.4 ACTION SUBMITTALS

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

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each MVE-control system, for tests performed by a qualified testing agency.
- C. Preinstallation testing reports.
- D. Field quality-control reports.

#### 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Employs factory-trained personnel who are available for consultation and Project-site inspection.
- B. Installer Qualifications: An authorized representative who is trained and approved by the manufacturer.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages and containers, with seals unbroken, bearing manufacturer's labels indicating directions for storage and mixing with other components.

## 1.8 FIELD CONDITIONS

- A. Environmental Limitations: Comply with MVE-control system manufacturer's written instructions for substrate and ambient temperatures, humidity, ventilation, and other conditions affecting system installation.
  - 1. Store system components in a temperature-controlled environment and protected from weather and at ambient temperature of not less than 65 deg F and not more than 85 deg F at least 48 hours before use.
  - 2. Maintain ambient temperature and relative humidity in installation areas within range recommended in writing by MVE-control system manufacturer, but not less than 65 deg F or more than 85 deg F and not less than 40 or more than 60 percent relative humidity, for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.
  - 3. Install MVE-control systems where concrete surface temperatures will remain a minimum of 5 deg F higher than the dew point for ambient temperature and relative humidity conditions in installation areas for 48 hours before installation, during installation, and for 48 hours after installation unless longer period is recommended in writing by manufacturer.

## PART 2 PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. MVE-Control System Capabilities: Capable of suppressing MVE without failure where installed on concrete that exhibits the following conditions:
  - 1. MVER: Maximum 15 lb of water/1000 sq. ft. when tested according to ASTM F1869.
  - 2. Relative Humidity: Maximum 100 percent when tested according to ASTM F2170 using in situ probes.
- B. Water-Vapor Transmission: Through MVE-control system, maximum 0.10 perm when tested according to ASTM E96/E96M.
- C. Tensile Bond Strength: For MVE-control system, greater than 300 psi with failure in the concrete according to ASTM D7234.

## 2.2 MVE-CONTROL SYSTEM

- A. Manufacturer:
  - 1. Basis of Design: Provide Vapor Ban ER moisture vapor barrier manufactured by Laticrete International, Inc. or an approved product manufactured by one of the following:
    - a. Ardex Americas
    - b. Mapei Corporation
    - c. Maxxon, Inc.
    - d. USG Corporation
- B. MVE-Control System: ASTM F3010-qualified, fluid-applied, two-component, epoxy-resin, membrane-forming system; formulated for application on concrete substrates to reduce MVER to level required for installation of floor coverings indicated and acceptable to manufacturers of floor covering products indicated, including adhesives.
  - 1. Substrate Primer: Provide MVE-control system manufacturer's concrete-substrate primer if required for system indicated by substrate conditions.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  - 1. Installation of system indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Preinstallation Testing:
  - 1. Testing Agency: Engage a qualified testing agency to perform tests.
  - 2. Moisture Testing: Perform tests so that each test area does not exceed 1000 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
    - a. Internal Relative Humidity Test: Using in situ probes, ASTM F2170. Install MVE-control system in locations where concrete substrates exhibit relative humidity level greater than 75 percent.
  - 3. Tensile-Bond-Strength Testing: For typical locations indicated to receive installation of MVE-control system, install minimum 100-sq. ft. area of MVE-control system to prepared concrete substrate and test according to ASTM D7234.

- a. Proceed with installation only where tensile bond strength is greater than 300 psi with failure in the concrete.
- B. Concrete Substrates: Prepare and clean substrates according to MVE-control system manufacturer's written instructions to ensure adhesion of system to concrete.
  1. Remove coatings and other substances that are incompatible with MVE-control system and that contain soap, wax, oil, or silicone, using mechanical methods recommended in writing by MVE-control system manufacturer. Do not use solvents.
  2. Provide concrete surface profile complying with ICRI 310.2R CSP 3 by shot blasting using apparatus that abrades the concrete surface with shot, contains the dispensed shot within the apparatus, and recirculates the shot by vacuum pickup.
  3. After shot blasting, repair damaged and deteriorated concrete according to MVE-control system manufacturer's written instructions.
  4. Protect substrate voids and joints to prevent resins from flowing into or leaking through them.
  5. Fill surface depressions and irregularities with patching and leveling material.
  6. Fill surface cracks, grooves, control joints, and other nonmoving joints with crack-filling material.
  7. Allow concrete to dry, undisturbed, for period recommended in writing by MVE-control system manufacturer after surface preparation, but not less than 24 hours.
  8. Before installing MVE-control systems, broom sweep and vacuum prepared concrete.
- C. Protect walls, floor openings, electrical openings, door frames, and other obstructions during installation.

### 3.3 INSTALLATION

- A. Install MVE-control system according to ASTM F3010 and manufacturer's written instructions to produce a uniform, monolithic surface free of surface deficiencies such as pin holes, fish eyes, and voids.
  1. Install primers as required to comply with manufacturer's written instructions.
- B. Do not apply MVE-control system across substrate expansion, isolation, and other moving joints.
- C. Apply system, including component coats if any, in thickness recommended in writing by MVE-control system manufacturer for MVER indicated by preinstallation testing.
- D. Cure MVE-control system components according to manufacturer's written instructions. Prevent contamination or other damage during installation and curing processes.

- E. After curing, examine MVE-control system for surface deficiencies. Repair surface deficiencies according to manufacturer's written instructions.

#### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform installation inspections.
- B. Installation Inspections: Inspect substrate preparation and installation of system components to ensure compliance with manufacturer's written instructions and to ensure that a complete MVE-control system is installed without deficiencies.
  - 1. Verify that surface preparation meets requirements.
  - 2. Verify that component coats and complete MVE-control-system film thicknesses comply with manufacturer's written instructions.
  - 3. Verify that MVE-control-system components and installation areas that evidence deficiencies are repaired according to manufacturer's written instructions.

#### 3.5 PROTECTION

- A. Protect MVE-control system from damage, wear, dirt, dust, and other contaminants before floor covering installation. Use protective methods and materials, including temporary coverings, recommended in writing by MVE-control system manufacturer.
- B. Do not allow subsequent preinstallation examination and testing for floor covering installation to damage, puncture, or otherwise compromise the MVE-control system membrane.

END OF SECTION

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## SECTION 092216 - NON-STRUCTURAL METAL FRAMING

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes non-load-bearing steel framing members for the following applications:
  - 1. Interior framing systems (e.g., supports for partition walls, framed soffits, furring, etc.)
  - 2. Interior suspension systems (e.g., supports for ceilings, suspended soffits, etc.)

#### 1.3 SUBMITTALS

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

#### 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.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

### PART 2 PRODUCTS

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

- A. Framing Members, General: Comply with ASTM C 754 for conditions indicated.
  - 1. Steel Sheet Components: Comply with ASTM C 645 requirements for metal, unless otherwise indicated.
  - 2. Protective Coating: ASTM A 653/A 653M, G60, hot-dip galvanized, unless otherwise indicated.

## 2.2 SUSPENSION SYSTEM COMPONENTS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625 inch diameter wire, or double strand of 0.0475 inch diameter wire.
- B. Hanger Attachments to Concrete:
  - 1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
    - a. Type: Cast-in-place anchor, designed for attachment to concrete forms; postinstalled, chemical anchor; and postinstalled, expansion anchor.
  - 2. Powder-Actuated Fasteners: Suitable for application indicated, fabricated from corrosion-resistant materials with clips or other devices for attaching hangers of type indicated, and capable of sustaining, without failure, a load equal to 10 times that imposed by construction as determined by testing according to ASTM E 1190 by an independent testing agency.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162 inch diameter.
- D. Flat Hangers: Steel sheet, 1 by 3/16 inch by length indicated.
- E. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2 inch wide flanges.
  - 1. Depth: 2 inches.
- F. Furring Channels (Furring Members):
  - 1. Cold-Rolled Channels: 0.0538 inch bare-steel thickness, with minimum 1/2 inch wide flanges, 3/4 inch deep.
  - 2. Steel Studs: ASTM C 645.
    - a. Minimum Base-Metal Thickness: 18 Gauge (0.0403 inch).
    - b. Depth: As indicated on Drawings.
  - 3. Hat-Shaped, Rigid Furring Channels: ASTM C 645, 7/8 inch deep.
    - a. Minimum Base Metal Thickness: 20 Gauge (0.0359 inch).
  - 4. Resilient Furring Channels: 1/2 inch deep members designed to reduce sound transmission.
    - a. Configuration: Asymmetrical or hat shaped.
- G. Grid Suspension System for Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Armstrong World Industries, Inc.; Drywall Grid Systems.
    - b. Chicago Metallic Corporation; Drywall Furring System.



- c. USG Corporation; Drywall Suspension System.

## 2.3 STEEL FRAMING FOR FRAMED ASSEMBLIES

- A. Steel Studs and Runners: ASTM C 645.
1. Minimum Base-Metal Thickness: 18 Gauge (0.0403 inch).
  2. Depth: As indicated on Drawings.
- B. Slip-Type Head Joints: Where indicated, provide one of the following:
1. Single Long-Leg Runner System: ASTM C 645 top runner with 2 inch deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
  2. Double-Runner System: ASTM C 645 top runners, inside runner with 2 inch deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
  3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
    - a. Products: Subject to compliance with requirements, provide one of the following:
      - 1) Steel Network Inc. (The); VertiClip SLD and/or VertiTrack VTD Series.
      - 2) Superior Metal Trim; Superior Flex Track System (SFT).
- C. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.
1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
  2. Products: Subject to compliance with requirements, provide one of the following:
    - a. Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Slip Clip.
    - b. Metal-Lite, Inc.; The System.
- D. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
1. Minimum Base-Metal Thickness: 20 Gauge (0.0359 inch).
- E. Cold-Rolled Channel Bridging: 0.0538 inch bare-steel thickness, with minimum 1/2 inch wide flanges.
1. Depth: 1-1/2 inches.
  2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068 inch thick, galvanized steel.
- F. Hat-Shaped, Rigid Furring Channels: ASTM C 645.

1. Minimum Base Metal Thickness: 20 Gauge (0.0359 inch).
  2. Depth: 7/8 inch.
- G. Resilient Furring Channels: 1/2 inch deep, steel sheet members designed to reduce sound transmission.
1. Configuration: Asymmetrical or hat shaped.
- H. Cold-Rolled Furring Channels: 0.0538 inch bare-steel thickness, with minimum 1/2 inch wide flanges.
1. Depth: 3/4 inch.
  2. Furring Brackets: Adjustable, corrugated-edge type of steel sheet with minimum bare-steel thickness of 20 Gauge (0.0359) inch.
  3. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch diameter wire, or double strand of 0.0475-inch- diameter wire.
- I. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum bare-metal thickness of 24 Gauge (0.0239 inch), and depth required to fit insulation thickness indicated. Provide custom sized furring in 1/2", 3/4" or 1" sizes to meet specific assembly thicknesses shown on details in the contract documents.
- J. Stud Wall Reinforcing Steel (Tube and Base Plate):
1. Provide heavy gauge steel manufactured product for reinforcing:
    - a. Low walls of metal framing that are 3'-0" to 6'-0" in height.
    - b. Metal framing at door jambs and strikes.
  2. Steel base plate metal thickness: 3/8 inch.
  3. Steel base plate dimensions: 3 inches x 8 inches with three holes for 1/2 inch diameter bolts.
  4. Size of vertical steel tube: 2 inch x 1 inch x 14 Gauge steel tube.
  5. Height of vertical steel tube: 34-1/2 inches.
  6. Vertical steel tube location on plate: Tube is at one end of base plate to brace low wall and offset on plate to allow conduits to pass by within reinforced low wall.
  7. Spacing for 3 ft high low wall: 6 ft. on center.
  8. Spacing for 4 ft. high low wall: 4 ft. on center.
  9. Spacing for 5 ft. high low wall: 4 ft. on center.
  10. Spacing for 6 ft. high low wall: 4 ft. on center.
  11. Base plate is secured to concrete floor slab with 1/2 inch diameter steel bolt fasteners with 3-1/2 inch minimum embedment.
  12. Manufacturer and Product:
    - a. NoFlex, Inc; NoFlex - The Low Wall Support Solution (Basis-of-Design)
      - 1) NoFlex, Inc.
      - 2) 9121 Atlanta Avenue, Suite 333
      - 3) Huntington Beach, California 92646

- 4) Ph: (800) 720-1994
    - 5) [www.noflex.com](http://www.noflex.com)
  - b. b. Approved equal.
- K. Extruded Aluminum Partition Closure: Provide specified lengths and size to fit specified openings.
  - 1. Material: Extruded aluminum, 6063-T5
  - 2. Finish: Factory-anodized in clear or medium bronze.
  - 3. Provide acoustic insulation (as specified) within concealed mullion chassis.
  - 4. Manufacturer and Product:
    - a. Gordon, Inc.
      - 1) 5023 Hazel Jones Road
      - 2) Bossier City, LA 71111
      - 3) Ph: (800) 747-8954
      - 4) Website: [www.gordoninteriors.com](http://www.gordoninteriors.com)
    - b. Or Approved equal.
  - 5. Basis of Design:
    - a. Terminations at Glass – Mullion Mate Series 40, or Approved Equal
    - b. Terminations at Mullions – Mullion Mat Series 30, or Approved Equal
  - 6. Partition Wall End Caps: Extruded aluminum end caps. Sized to fit partition or wall assembly.
    - a. AUXILIARY MATERIALS
- L. General: Provide auxiliary materials that comply with referenced installation standards.
  - 1. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- M. Isolation Strip at Exterior Walls: Provide the following:
  - 1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and structural framing, for compliance with requirements and other conditions affecting performance.
  - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Suspended Assemblies: Coordinate installation of suspension systems with installation of overhead structure to ensure that inserts and other provisions for anchorages to building structure have been installed to receive hangers at spacing required to support the Work and that hangers will develop their full strength.
  - 1. Furnish concrete inserts and other devices indicated to other trades for installation in advance of time needed for coordination and construction.

### 3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754, except comply with framing sizes and spacing indicated.
  - 1. Gypsum Plaster Assemblies: Also comply with requirements in ASTM C 841 that apply to framing installation.
  - 2. Portland Cement Plaster Assemblies: Also comply with requirements in ASTM C 1063 that apply to framing installation.
  - 3. Gypsum Veneer Plaster Assemblies: Also comply with requirements in ASTM C 844 that apply to framing installation.
  - 4. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

### 3.4 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
  - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
    - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
    - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
  3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
  4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
  5. Do not attach hangers to steel roof deck.
  6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
  7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
  8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- F. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

### 3.5 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 studs so flanges within framing system point in same direction.
  1. Space studs as follows:
    - a. Single-Layer Application: 16 inches o.c., unless otherwise indicated.
    - b. Multilayer Application: 16 inches o.c., unless otherwise indicated.
- C. 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 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.
- D. Direct Furring:
1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
- E. Z-Furring Members:
1. Erect insulation vertically and hold in place with Z-furring members spaced 24 inches o.c.
  2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
  3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.
  4. Install custom furring over support framing as shown in the details in the contract documents.
- F. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

END OF SECTION

## SECTION 092900 - GYPSUM BOARD

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Gypsum board for wall panels, soffits, and ceilings.
- B. Related Requirements:
  - 1. Section 092216 "Non-Structural Metal Framing" for non-structural steel framing and suspension systems that support gypsum board panels.
  - 2. Section 093013 "Ceramic Tiling" for cementitious backer units installed as substrates for ceramic tile.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For the following:
  - 1. Gypsum wallboard.
  - 2. Gypsum board, Type X.
  - 3. Abuse-resistant gypsum board.
  - 4. Impact-resistant gypsum board.
  - 5. Mold-resistant gypsum board.
  - 6. Glass-mat interior gypsum board.
  - 7. Glass-mat gypsum sheathing board.
  - 8. Interior trim.
  - 9. Exterior trim.
  - 10. Aluminum trim.
  - 11. Joint treatment materials.
  - 12. Laminating adhesive.
- B. Shop Drawings: Show locations and installation of control and expansion joints, including plans, elevations, sections, details of components, and attachments to other work.
- C. Samples: For the following products:
  - 1. Trim Accessories: Full-size Sample in 12-inch long length for each trim accessory indicated.

#### 1.3 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

#### 1.4 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.
- B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, and mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

### PART 2 PRODUCTS

#### 2.1 SOURCE LIMITATIONS

- A. Obtain each type of gypsum panel and joint finishing material from single source with resources to provide products of consistent quality in appearance and physical properties.

#### 2.2 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

#### 2.3 GYPSUM BOARD, GENERAL

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

#### 2.4 INTERIOR GYPSUM BOARD



- A. General: Complying with ASTM C 36/C 36M or ASTM C 1396/C 1396M, as applicable to type of gypsum board indicated and whichever is more stringent.
  - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
    - a. American Gypsum Co.
    - b. BPB America Inc.
    - c. G-P Gypsum.
    - d. Lafarge North America Inc.
    - e. National Gypsum Company.
    - f. PABCO Gypsum.
    - g. Temple.
    - h. USG Corporation.
- B. Gypsum Wallboard: ASTM C1396/C1396M.
  - 1. Thickness: 1/2 inch.
  - 2. Long Edges: Tapered.
- C. Gypsum Board, Type X: ASTM C1396/C1396M.
  - 1. Thickness: 5/8 inch.
  - 2. Long Edges: Tapered
  - 3. Fire resistance: Core material shall be specially formulated for a type X classification as defined in ASTM C36. Board material shall exhibit a 15 flame spread, as manufactured, per ASTM E84.
- D. Abuse-Resistant Gypsum Board: ASTM C1396/C1396M gypsum board, tested according to ASTM C1629/C1629M.
  - 1. Core: 5/8 inch, Type X.
  - 2. Long Edges: Tapered.
  - 3. Abuse resistance: Board surface facing occupied space shall have a special heavy duty paper or inorganic facing specially designed to resist abrasion, scratching, indentation and puncture. The board core shall be specially formulated with inorganic binders to achieve a higher bending strength and resistance to soft body impact.
- E. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.
  - 1. Core: 5/8 inch, Type X.
  - 2. Long Edges: Tapered.
  - 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.
    - a. Back face of board (facing cavity) shall have a coated inorganic glass facing. The board core shall be formulated to be resistant to mold.

## 2.5 SPECIALTY GYPSUM BOARD

- A. Glass-Mat Interior Gypsum Board: ASTM C1658/C1658M. With fiberglass mat laminated to both sides. Specifically designed for interior use.
  - 1. Core: 1/2 inch, regular type.
  - 2. Long Edges: Tapered.
  - 3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

## 2.6 EXTERIOR GYPSUM BOARD FOR CEILINGS AND SOFFITS

- A. Glass-Mat Gypsum Sheathing Board: ASTM C1177/C1177M, with fiberglass mat laminated to both sides and with manufacturer's standard edges.
  - 1. Core: 1/2 inch, regular type.

## 2.7 TRIM ACCESSORIES

- A. Interior Trim: ASTM C1047.
  - 1. Material: Galvanized or aluminum-coated steel sheet, rolled zinc, plastic, or paper-faced galvanized-steel sheet.
  - 2. Shapes:
    - a. Cornerbead.
    - b. Bullnose bead.
    - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
    - d. L-Bead: L-shaped; exposed long flange receives joint compound.
    - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
    - f. Expansion (control) joint.
    - g. Curved-Edge Cornerbead: With notched or flexible flanges.
    - h. Base-of-Wall Galvanized Moisture Barrier Trim: Galvanized-steel sheet, 2 inches high.
- B. Exterior Trim: ASTM C1047.
  - 1. Material: Hot-dip galvanized-steel sheet, plastic, or rolled zinc.
  - 2. Shapes:
    - a. Cornerbead.
    - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
    - c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.
- C. Aluminum Trim: Extruded accessories of profiles and dimensions indicated.
  - 1. Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B221, Alloy 6063-T5.
  - 2. Finish: Corrosion-resistant primer compatible with joint compound and finish materials specified.

## 2.8 JOINT TREATMENT MATERIALS

- A. General: Comply with ASTM C475/C475M.
- B. Joint Tape:
  - 1. Interior Gypsum Board: Paper.
  - 2. Exterior Gypsum Soffit Board: Paper.
  - 3. Glass-Mat Gypsum Sheathing Board: 10-by-10 glass mesh.
  - 4. Tile Backing Panels: As recommended by panel manufacturer.
- C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.
  - 1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
  - 2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use drying-type, all-purpose compound.
  - 3. Fill Coat: For second coat, use drying-type, all-purpose compound.
  - 4. Finish Coat: For third coat, use setting-type, sandable topping compound.
  - 5. Skim Coat: For final coat of Level 5 finish, use high-build interior coating product designed for application by airless sprayer and to be used instead of skim coat to produce Level 5 finish.
- D. Joint Compound for Exterior Applications:
  - 1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
  - 2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.
- E. Joint Compound for Tile Backing Panels:
  - 1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
  - 2. Cementitious Backer Units: As recommended by backer unit manufacturer.
  - 3. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

## 2.9 AUXILIARY MATERIALS

- A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.
- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. Steel Drill Screws: ASTM C1002 unless otherwise indicated.

1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
- D. Thermal Insulation: As specified in Section 072100 "Thermal Insulation."
- E. Vapor Retarder: As specified in Section 072600 "Vapor Retarders."

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and support framing, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION AND FINISHING OF PANELS, GENERAL

- A. Comply with ASTM C840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
  1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
  2. Fit gypsum panels around ducts, pipes, and conduits.

3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4 to 3/8 inch wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4 to 1/2 inch wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.
- I. Wood Framing: Install gypsum panels over wood framing, with floating internal corner construction. Do not attach gypsum panels across the flat grain of wide-dimension lumber, including floor joists and headers. Float gypsum panels over these members or provide control joints to counteract wood shrinkage.
- J. STC-Rated Assemblies: Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
- K. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

### 3.3 INSTALLATION OF INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
  1. Wallboard Type: Soffits and ceilings, where indicated on Drawings.
  2. Type X: Fire-resistance-rated assemblies, where indicated on Drawings.
  3. Abuse-Resistant Type: High-traffic, utility, and vehicle storage areas, where indicated on Drawings.
  4. Mold-Resistant Type: Wet areas, where indicated on Drawings.
  5. Glass-Mat Type: Exterior applications and building envelop assemblies, where indicated on Drawings.
- 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 vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

- a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
      - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
    3. On Z-shaped 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.
  - C. Multilayer Application:
    1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
    2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
    3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
    4. Fastening Methods: Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners.
  - D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.
- 3.4 INSTALLATION OF EXTERIOR GYPSUM PANELS FOR CEILINGS AND SOFFITS
- A. Apply panels perpendicular to supports, with end joints staggered and located over supports.
    1. Install with 1/4 inch open space where panels abut other construction or structural penetrations.
    2. Fasten with corrosion-resistant screws.
- 3.5 INSTALLATION OF TRIM ACCESSORIES
- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

- B. Control Joints: Install control joints according to ASTM C840 and in specific locations approved by Architect for visual effect.
- C. Interior Trim: Install in the following locations:
  - 1. Cornerbead: Use at outside corners unless otherwise indicated.
  - 2. Bullnose Bead: Use at outside corners.
  - 3. L-Bead: Use where indicated on Drawings.
  - 4. LC-Bead: Use at exposed panel edges.
- D. Exterior Trim: Install in the following locations:
  - 1. Cornerbead: Use at outside corners.
  - 2. LC-Bead: Use at exposed panel edges.
- E. Aluminum Trim: Install in locations indicated on Drawings.

### 3.6 FINISHING OF 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 for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C840:
  - 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
  - 2. Level 2: Panels that are substrate for tile.
  - 3. Level 3: Where indicated on Drawings.
  - 4. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
  - 5. Level 5: Where indicated on Drawings.
- E. Glass-Mat Gypsum Sheathing Board: Finish according to manufacturer's written instructions for use as exposed soffit board.
- F. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.
- G. Cementitious Backer Units: Finish according to manufacturer's written instructions.

### 3.7 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
  - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
  - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION



## SECTION 093013 - CERAMIC TILING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Ceramic tile for floors and walls.
  - 2. Thresholds.
  - 3. Tile backing panels.
  - 4. Waterproof membranes.
  - 5. Setting materials.
- B. Related Requirements:
  - 1. Section 079200 Joint Sealants for sealing of expansion, contraction, control, and isolation joints in tile surfaces.

#### 1.2 DEFINITIONS

- A. General: Definitions in the ANSI A108 series of tile installation standards and in ANSI A137.1 apply to Work of this Section unless otherwise specified.
- B. Face Size: Actual tile size, excluding spacer lugs.
- C. Module Size: Actual tile size plus joint width indicated.

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction, control, and isolation joints in tile substrates and finished tile surfaces.
- C. Samples for Initial Selection: For tile, grout, and accessories involving color selection.
- D. Samples for Verification:

1. Full-size units of each type and composition of tile and for each color and finish required.
2. Assembled samples mounted on a rigid panel, with grouted joints, for each type and composition of tile and for each color and finish required. Make samples at least 12 inches square, but not fewer than four tiles. Use grout of type and in color or colors approved for completed Work.
3. Full-size units of each type of trim and accessory.
4. Stone thresholds in 6-inch lengths.
5. Metal edge strips in 6-inch lengths.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Master Grade Certificates: For each shipment, type, and composition of tile, signed by tile manufacturer and Installer.
- C. Product Certificates: For each type of product.
- D. Product Test Reports: For tile-setting and grouting products.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match and are from same production runs as products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  1. Tile and Trim Units: Furnish quantity of full-size units equal to 3 percent of amount installed for each type, composition, color, pattern, and size indicated.
  2. Grout: Furnish quantity of grout equal to 3 percent of amount installed for each type, composition, and color indicated.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
  1. Installer is a member of the National Tile Contractors Association or a Trowel of Excellence member of the Tile Contractors' Association of America.
- B. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
  1. Build mockup of each type of floor tile installation.
  2. Build mockup of each type of wall tile installation.
  3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirements in ANSI A137.1 for labeling tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination can be avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

## 1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient temperature and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations for Tile: Obtain tile of each type and color or finish from single source or producer.
  - 1. Obtain tile of each type and color or finish from same production run and of consistent quality in appearance and physical properties for each contiguous area.
- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from single manufacturer and each aggregate from single source or producer.
  - 1. Obtain setting and grouting materials, except for unmodified Portland cement and aggregate, from single manufacturer.
  - 2. Obtain waterproof membrane and crack isolation membrane, except for sheet products, from manufacturer of setting and grouting materials.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section from a single manufacturer:
  - 1. Stone thresholds.
  - 2. Waterproof membrane.
  - 3. Crack isolation membrane.
  - 4. Cementitious backer units.

### 2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1 for types, compositions, and other characteristics indicated.
  - 1. Provide tile complying with Standard grade requirements.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCNA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer unless otherwise indicated.
  - 1. Where tile is indicated for installation in wet areas, do not use back- or edge-mounted tile assemblies unless tile manufacturer specifies in writing that this type of mounting is suitable for installation indicated and has a record of successful in-service performance.

## 2.3 TILE PRODUCTS

- A. Ceramic Floor Tile (CFT):
  - 1. Basis of Design: Provide products by the manufacturers indicated on the drawings Subject to compliance with requirements, and subject to color and other aesthetic approval at the sole discretion of the Architect, other available manufacturers offering products that may be incorporated into the work include, but are not limited to the following:
    - a. American Marazzi Tile, Inc.
    - b. American Olean; Division of Dal-Tile International Inc.
    - c. Best Tile
    - d. Daltile; Division of Dal-Tile International, Inc.
    - e. Florida Tile Industries, Inc.
    - f. Florim USA
    - g. Laufen
    - h. Mosa USA
    - i. Portobello America, Inc.
    - j. Seneca Tiles, Inc.
    - k. United States Ceramic Tile Company
  - 2. Style: As indicated in the drawings.
  - 3. Module Size: As indicated on the drawings.
  - 4. Thickness: Per style indicated on the drawings.
  - 5. Finish: Per style indicated on the drawings.

6. Tile Color and Pattern: As selected by Architect from manufacturer's full range.
  7. Grout Color: As selected by Architect from manufacturer's full range.
  8. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
- B. Ceramic Tile Base (CTB):
1. Basis of Design: Provide products by the manufacturers indicated on the drawings Subject to compliance with requirements, and subject to color and other aesthetic approval at the sole discretion of the Architect, other available manufacturers offering products that may be incorporated into the work include, but are not limited to the following:
    - a. American Marazzi Tile, Inc.
    - b. American Olean; Division of Dal-Tile International Inc.
    - c. Best Tile
    - d. Daltile; Division of Dal-Tile International, Inc.
    - e. Florida Tile Industries, Inc.
    - f. Florim USA
    - g. Laufen
    - h. Mosa USA
    - i. Portobello America, Inc.
    - j. Seneca Tiles, Inc.
    - k. United States Ceramic Tile Company
  2. Style: As indicated in the drawings.
  3. Module Size: As indicated on the drawings.
  4. Thickness: Per style indicated on the drawings.
  5. Finish: Per style indicated on the drawings.
  6. Tile Color and Pattern: As selected by Architect from manufacturer's full range.
  7. Grout Color: As selected by Architect from manufacturer's full range.
  8. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
- C. Ceramic Wall Tile (CWT):
1. Basis of Design: Provide products by the manufacturers indicated on the drawings Subject to compliance with requirements, and subject to color and other aesthetic approval at the sole discretion of the Architect, other available manufacturers offering products that may be incorporated into the work include, but are not limited to the following:
    - a. American Marazzi Tile, Inc.
    - b. American Olean; Division of Dal-Tile International Inc.
    - c. Best Tile
    - d. Daltile; Division of Dal-Tile International, Inc.

- e. Florida Tile Industries, Inc.
- f. Florim USA
- g. Laufen
- h. Mosa USA
- i. Portobello America, Inc.
- j. Seneca Tiles, Inc.
- k. United States Ceramic Tile Company
- 2. Module Size: As indicated on the drawings.
- 3. Thickness: Per style indicated on the drawings.
- 4. Finish: Per style indicated on the drawings.
- 5. Tile Color and Pattern: As selected by Architect from manufacturer's full range.
- 6. Grout Color: As selected by Architect from manufacturer's full range.
- 7. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
- D. Accessories: Provide vitreous china accessories of type and size indicated, suitable for installing by same method as used for adjoining wall tile.

## 2.4 THRESHOLDS

- A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes.
  - 1. Bevel edges at 1:2 slope, with lower edge of bevel aligned with or up to 1/16 inch above adjacent floor surface. Finish bevel to match top surface of threshold. Limit height of threshold to 1/2 inch or less above adjacent floor surface.
- B. Marble Thresholds: ASTM C503/C503M, with a minimum abrasion resistance of 10 according to ASTM C1353 or ASTM C241/C241M and with honed finish.
  - 1. Description:
    - a. Uniform, fine to medium grained white stone with gray veining.

## 2.5 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 or ASTM C1325, Type A, in maximum lengths available to minimize end-to-end butt joints.
  - 1. Thickness: 1/4 inch.

## 2.6 WATERPROOF MEMBRANES

- A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.

- B. Waterproof Membrane, Fluid-Applied: Liquid-latex rubber or elastomeric polymer.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Hydro Ban Single Component, Self-Curing, Fluid-Applied from Laticrete, or comparable product by one of the following:
    - a. Boiardi Products; a QEP company
    - b. Bonsal American; an Oldcastle company
    - c. Bostik, Inc.
    - d. C-Cure
    - e. Custom Building Products
    - f. Jamo Inc.
    - g. MAPEI Corporation
    - h. Southern Grouts & Mortars, Inc
    - i. TEC; a subsidiary of H. B. Fuller Company

## 2.7 SETTING MATERIALS

- A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.02.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide 254 Platinum Thin Set Mortar from Laticrete, or comparable product by one of the following:
    - a. Boiardi Products; a QEP company.
    - b. Bonsal American; an Oldcastle company.
    - c. Bostik, Inc.
    - d. C-Cure.
    - e. Custom Building Products.
    - f. Jamo Inc.
    - g. MAPEI Corporation.
    - h. Mer-Kote Products, Inc.
    - i. Southern Grouts & Mortars, Inc.
    - j. Summitville Tiles, Inc.
    - k. TEC; a subsidiary of H. B. Fuller Company.
  - 2. Locations: All tile wall locations, unless otherwise noted.
  - 3. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.
  - 4. For wall applications, provide non-sag latex modified thin set mortar that complies with requirements for nonsagging mortar in addition to the other requirements in ANSI A118.15T.
    - a. Polymer-Portland Cement Mortar (Fortified): ANSI A118.4.
  - 5. Basis-of-Design Product: Subject to compliance with requirements, provide 3701 Fortified Mortar Bed from Laticrete, or comparable product by one of the following:
    - a. Boiardi Products; a QEP company.

- b. Bonsal American; an Oldcastle company.
  - c. Bostik, Inc.
  - d. C-Cure.
  - e. Custom Building Products.
  - f. Jamo Inc.
  - g. MAPEI Corporation.
  - h. Mer-Kote Products, Inc.
  - i. Southern Grouts & Mortars, Inc.
  - j. Summitville Tiles, Inc.
  - k. TEC; a subsidiary of H. B. Fuller Company.
- 6. Locations: All floor tile locations, unless otherwise noted.
  - 7. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.

## 2.8 GROUT MATERIALS

- A. Water-Cleanable Epoxy Grout: ANSI A118.3, with a VOC content of 65 g/L or less.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Spectralock Pro Premium Grout from Laticrete, or comparable product by one of the following:
    - a. Atlas Minerals & Chemicals, Inc.
    - b. Boiardi Products; a QEP company.
    - c. Bonsal American; an Oldcastle company.
    - d. Bostik, Inc.
    - e. C-Cure.
    - f. Custom Building Products.
    - g. Jamo Inc.
    - h. MAPEI Corporation.
    - i. Mer-Kote Products, Inc.
    - j. Southern Grouts & Mortars, Inc.
    - k. Summitville Tiles, Inc.
    - l. TEC; a subsidiary of H. B. Fuller Company.
  - 2. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 deg F (60 deg C) and 212 deg F (100 deg C), respectively, and certified by manufacturer for intended use.

## 2.9 ELASTOMERIC SEALANTS

- A. General: Provide sealants, primers, backer rods, and other sealant accessories that comply with the following requirements and with the applicable requirements in Division 07 Section "Joint Sealants."
  - 1. Sealants shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).



2. 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."
3. Use primers, backer rods, and sealant accessories recommended by sealant manufacturer.
  - a. Colors: Provide colors of exposed sealants to match colors of grout in tile adjoining sealed joints unless otherwise indicated.
  - b. One-Part, Mildew-Resistant Silicone Sealant: ASTM C 920; Type S; Grade NS; Class 25; Uses NT, G, A, and, as applicable to nonporous joint substrates indicated, O; formulated with fungicide, intended for sealing interior porcelain tile joints and other nonporous substrates that are subject to in-service exposures of high humidity and extreme temperatures.
4. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
  - a. DAP Inc.; 100 percent Silicone Kitchen and Bath Sealant.
  - b. Dow Corning Corporation; Dow Corning 786.
  - c. GE Silicones; a division of GE Specialty Materials; Sanitary 1700.
  - d. Laticrete International, Inc.; Latasil Tile & Stone Sealant.
  - e. Pecora Corporation; Pecora 898 Sanitary Silicone Sealant.
  - f. Tremco Incorporated; Tremsil 600 White.

#### 2.10 MISCELLANEOUS MATERIALS

- A. Metal Edge Strips: Angle or L-shaped, height to match tile and setting-bed thickness, metallic or combination of metal and PVC or neoprene base, designed specifically for flooring applications; stainless steel, exposed-edge material.
- B. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.

#### 2.11 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions.
- B. Add materials, water, and additives in accurate proportions.
- C. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

### PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
  - 1. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials, including curing compounds and other substances that contain soap, wax, oil, or silicone; and comply with flatness tolerances required by ANSI A108.01 for installations indicated.
  - 2. Verify that concrete substrates for tile floors installed with adhesives, bonded mortar bed, or thinset mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
    - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
    - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
  - 3. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed.
  - 4. Verify that joints and cracks in tile substrates are coordinated with tile joint locations; if not coordinated, adjust joint locations in consultation with Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thinset mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer. Floor substrates shall be verified. If uneven floor substrates are encountered, leveling materials shall be provided to ensure new floor finishes do not require transitions between similar materials.
- B. Where indicated, prepare substrates to receive waterproof membrane by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.
- C. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended either return to manufacturer or blend tiles at Project site before installing.

### 3.3 INSTALLATION OF CERAMIC TILE

- A. Comply with TCNA's "Handbook for Ceramic, Glass, and Stone Tile Installation" for TCNA installation methods specified in tile installation schedules. Comply with parts of the ANSI A108 series "Specifications for Installation of Ceramic Tile" that are referenced in TCNA installation methods, specified in tile installation schedules, and apply to types of setting and grouting materials used.
  - 1. For the following installations, follow procedures in the ANSI A108 series of tile installation standards for providing 95 percent mortar coverage:
    - a. Exterior tile floors.
    - b. Tile floors in wet areas.
    - c. Tile swimming pool decks.
    - d. Tile floors in laundries.
    - e. Tile floors consisting of tiles 8 by 8 inches or larger.
    - f. Tile floors consisting of rib-backed tiles.
- B. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- C. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile.
- D. Provide manufacturer's standard trim shapes where necessary to eliminate exposed tile edges.
- E. Where accent tile differs in thickness from field tile, vary setting-bed thickness so that tiles are flush.
- F. Jointing Pattern: Lay tile in grid pattern unless otherwise indicated. Lay out tile work and center tile fields in both directions in each space or on each wall area. Lay out tile work to minimize the use of pieces that are less than half of a tile. Provide uniform joint widths unless otherwise indicated.
  - 1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
  - 2. Where adjoining tiles on floor, base, walls, or trim are specified or indicated to be same size, align joints.
  - 3. Where tiles are specified or indicated to be whole integer multiples of adjoining tiles on floor, base, walls, or trim, align joints unless otherwise indicated.
- G. Joint Widths: Unless otherwise indicated, install tile with the following joint widths:
  - 1. Ceramic Tile: 3/8 inch.

- H. Lay out tile wainscots to dimensions indicated or to next full tile beyond dimensions indicated.
- I. Expansion Joints: Provide expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated. Form joints during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
  - 1. Where joints occur in concrete substrates, locate joints in tile surfaces directly above them.
- J. Stone Thresholds: Install stone thresholds in same type of setting bed as adjacent floor unless otherwise indicated.
  - 1. At locations where mortar bed (thickset) would otherwise be exposed above adjacent floor finishes, set thresholds in modified dry-set mortar (thinset).
  - 2. Do not extend cleavage membrane, waterproof membrane, or crack isolation membrane under thresholds set in dry-set mortar. Fill joints between such thresholds and adjoining tile set on cleavage membrane, waterproof membrane, or crack isolation membrane with elastomeric sealant.
- K. Metal Edge Strips: Install where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated.
- L. Floor Sealer: Apply floor sealer to cementitious grout joints in tile floors according to floor-sealer manufacturer's written instructions. As soon as floor sealer has penetrated grout joints, remove excess sealer and sealer from tile faces by wiping with soft cloth.

### 3.4 INSTALLATION OF TILE BACKING PANELS

- A. Install panels and treat joints according to ANSI A108.11 and manufacturer's written instructions for type of application indicated. Use modified dry-set mortar for bonding material unless otherwise directed in manufacturer's written instructions.

### 3.5 INSTALLATION OF WATERPROOF MEMBRANES

- A. Install waterproof membrane to comply with ANSI A108.13 and manufacturer's written instructions to produce waterproof membrane of uniform thickness that is bonded securely to substrate.
- B. Allow waterproof membrane to cure and verify by testing that it is watertight before installing tile or setting materials over it.

### 3.6 INSTALLATION OF CRACK ISOLATION MEMBRANES

- A. Install crack isolation membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness that is bonded securely to substrate.
- B. Allow crack isolation membrane to cure before installing tile or setting materials over it.

### 3.7 ADJUSTING AND CLEANING

- A. Remove and replace tile that is damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
  - 1. Remove grout residue from tile as soon as possible.
  - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.

### 3.8 PROTECTION

- A. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear. If recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors.
- B. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- C. Before final inspection, remove protective coverings and rinse neutral protective cleaner from tile surfaces.

### 3.9 INTERIOR CERAMIC TILE INSTALLATION SCHEDULE

- A. Interior Floor Installations
  - 1. Ceramic Floor Tile (CFT): Fortified Polymer-Portland Cement Mortar with Waterproof Membrane over Concrete Substrate.
    - a. Designation: TCNA F121.
    - b. Waterproofing: Sheet Waterproof Membrane.
    - c. Bond Coat: Latex-Portland Cement Mortar.
    - d. Mortar Bed: Fortified Polymer-Portland Cement Mortar.
    - e. Grout: Water-Cleanable Epoxy Grout.
    - f. Interior Wall and Base Installations

2. Ceramic Tile Base (CTB) and Ceramic Wall Tile (CWT): Portland Cement Mortar over Cementitious Backer Board Substrate.
  - a. Designation: TCA W244C.
  - b. Cementitious Backer Unit: Cement Backer Board
  - c. Waterproofing: Sheet Waterproof Membrane.
  - d. Bond Coat: Portland Cement Mortar.
  - e. Grout: Water-Cleanable Epoxy Grout.

END OF SECTION

## SECTION 095113 - ACOUSTICAL PANEL CEILINGS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes acoustical panels and exposed suspension systems for interior ceilings.

#### 1.3 PREINSTALLATION MEETINGS

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

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, 6 inches in size.
- C. Samples for Initial Selection: For components with factory-applied finishes.
- D. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of sizes indicated below:
  - 1. Acoustical Panels: Set of 6-inch square samples of each type, color, pattern, and texture.
  - 2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch long samples of each type, finish, and color.
  - 3. Clips: Full-size hold-down clips.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Ceiling suspension-system members.
  - 2. Structural members to which suspension systems will be attached.
  - 3. Method of attaching hangers to building structure.

- a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
    4. Carrying channels or other supplemental support for hanger-wire attachment where conditions do not permit installation of hanger wires at required spacing.
    5. Size and location of initial access modules for acoustical panels.
    6. Items penetrating finished ceiling and ceiling-mounted items including the following:
      - a. Lighting fixtures.
      - b. Diffusers.
      - c. Grilles.
      - d. Speakers.
      - e. Access panels.
      - f. Perimeter moldings.
    7. Show operation of hinged and sliding components covered by or adjacent to acoustical panels.
  - B. Qualification Data: For testing agency.
  - C. Product Test Reports: For each acoustical panel ceiling, for tests performed by a qualified testing agency.
  - D. Evaluation Reports: For each acoustical panel ceiling suspension system and anchor and fastener type, from ICC-ES.
  - E. Field quality-control reports.
- 1.6 CLOSEOUT SUBMITTALS
- A. Maintenance Data: For finishes to include in maintenance manuals.
- 1.7 MAINTENANCE MATERIAL SUBMITTALS
- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
    1. Acoustical Ceiling Units: Full-size panels equal to 2 percent of quantity installed.
    2. Suspension-System Components: Quantity of each exposed component equal to 2 percent of quantity installed.
    3. Hold-Down Clips: Equal to 2 percent of quantity installed.
- 1.8 QUALITY ASSURANCE
- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
    1. Build mockup of typical ceiling area as shown on Drawings.



2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension-system components, and accessories to Project site and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

#### 1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
  1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of acoustical ceiling panel and its supporting suspension system from single source from single manufacturer.

#### 2.2 PERFORMANCE REQUIREMENTS

- A. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  1. Flame-Spread Index: Class A according to ASTM E1264.
  2. Smoke-Developed Index: 50 or less.
- B. Fire-Resistance Ratings: Comply with ASTM E119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  1. Indicate design designations from UL or from the listings of another qualified testing agency.

## 2.3 ACOUSTICAL PANELS

- A. Acoustical Panel Standard: Provide manufacturer's standard panels according to ASTM E1264 and designated by type, form, pattern, acoustical rating, and light reflectance unless otherwise indicated.
- B. Classification: Provide fire-resistance-rated panels as follows:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide products by USG Interiors, Inc., or comparable product by one of the following:
  - 1. Armstrong World Industries, Inc
  - 2. CertainTeed Corp.
  - 3. Chicago Metallic Corporation.
- D. Ceiling Type (Typical)
  - 1. Style: Mars Acoustical Panels.
  - 2. Color: White.
  - 3. LR: Not less than 0.90.
  - 4. NRC: Not less than 0.75.
  - 5. CAC: Not less than 35.
  - 6. Edge/Joint Detail: Tapered edge, Shadowline Tapered (SLT)
  - 7. Thickness: 3/4 inch.
  - 8. Modular Size: 24 by 24 inches.
  - 9. Model Number: 86785

## 2.4 METAL SUSPENSION SYSTEM

- A. Metal Suspension-System Standard: Provide manufacturer's standard, direct-hung, metal suspension system and accessories according to ASTM C635/C635M and designated by type, structural classification, and finish indicated.
- B. Basis-of-Design Product: Subject to compliance with requirements, provide 15/16" DX Exposed Acoustical Suspension System by USG Interiors, Inc., or comparable product by one of the following:
  - 1. Armstrong World Industries, Inc.
  - 2. CertainTeed Corp.
  - 3. Chicago Metallic Corporation.
- C. Wide-Face, Capped, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; pre-painted, electrolytically zinc coated, or hot-dip galvanized, G30 coating designation; with prefinished 15/16-inch wide metal caps on flanges.
  - 1. Structural Classification: Intermediate
  - 2. End Condition of Cross Runners: Override (stepped) or butt-edge type.
  - 3. Face Design: Flat, flush.

4. Cap Material: Cold-rolled steel.
5. Cap Finish: As selected by Architect from manufacturer's full range of standard colors.

## 2.5 ACCESSORIES

- A. Attachment Devices: Size for five times the design load indicated in ASTM C635/C635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.
- B. Wire Hangers, Braces, and Ties: Provide wires as follows:
  1. Zinc-Coated, Carbon-Steel Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper.
  2. Stainless-Steel Wire: ASTM A580/A580M, Type 304, nonmagnetic.
  3. Nickel-Copper-Alloy Wire: ASTM B164, nickel-copper-alloy UNS No. N04400.
  4. Size: Wire diameter sufficient for its stress at three times hanger design load (ASTM C635/C635M, Table 1, "Direct Hung") will be less than yield stress of wire, but not less than 0.106-inch diameter wire.
- C. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.
- D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.
- E. Hold-Down Clips: Manufacturer's standard hold-down.

## 2.6 METAL EDGE MOLDINGS AND TRIM

- A. Basis-of-Design Product: Subject to compliance with requirements, provide products by USG Interiors, Inc., or comparable product by one of the following:
  1. Armstrong World Industries, Inc.
  2. CertainTeed Corp.
  3. Chicago Metallic Corporation.
- B. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Type and profile indicated or, if not indicated, manufacturer's standard moldings for edges and penetrations that comply with seismic design requirements; formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners.
  1. Edge moldings shall fit acoustical panel edge details and suspension systems indicated and match width and configuration of exposed runners unless otherwise indicated.
  2. For lay-in panels with reveal edge details, provide stepped edge molding that forms reveal of same depth and width as that formed between edge of panel and flange at exposed suspension member.
  3. For circular penetrations of ceiling, provide edge moldings fabricated to diameter required to fit penetration exactly.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders unless otherwise indicated and comply with layout shown on reflected ceiling plans.
- B. Layout openings for penetrations centered on the penetrating items.

### 3.3 INSTALLATION

- A. Install acoustical panel ceilings according to ASTM C636/C636M and manufacturer's written instructions.
  - 1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.
- B. Suspend ceiling hangers from building's structural members and as follows:
  - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
  - 2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, counter-splaying, or other equally effective means.
  - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.

4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly to structure or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
  5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
  6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post-installed mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
  7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
  8. Do not attach hangers to steel deck tabs.
  9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
  10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
  11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards.
- C. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or post-installed anchors.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
  2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends. Miter corners accurately and connect securely.
  3. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide precise fit.

1. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
2. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
3. Install hold-down clips in areas indicated; space according to panel manufacturer's written instructions unless otherwise indicated.
  - a. Hold-Down Clips: Space 24 inches o.c. on all cross runners.
4. Protect lighting fixtures and air ducts according to requirements indicated for fire-resistance-rated assembly.

### 3.4 ERECTION TOLERANCES

- A. Suspended Ceilings: Install main and cross runners level to a tolerance of 1/8 inch in 12 feet, non-cumulative.
- B. Moldings and Trim: Install moldings and trim to substrate and level with ceiling suspension system to a tolerance of 1/8 inch in 12 feet, non-cumulative.

### 3.5 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
  1. Periodic inspection during the installation of suspended ceiling grids according to ASCE/SEI 7.
- B. Acoustical panel ceiling hangers, anchors, and fasteners will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### 3.6 CLEANING

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage.
- B. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

## SECTION 096513 - RESILIENT BASE AND ACCESSORIES

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Resilient base.
  - 2. Resilient molding accessories.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For each exposed product and for each color and texture specified, not less than 12 inches long.
- C. Samples for Initial Selection: For each type of product indicated.
- D. Samples for Verification: For each type of product indicated and for each color, texture, and pattern required in manufacturer's standard-size Samples, but not less than 12 inches long.
- E. Product Schedule: For resilient base and accessory products. Use same designations indicated on Drawings.

#### 1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Furnish not less than 10 linear feet for every 500 linear feet or fraction thereof, of each type, color, pattern, and size of resilient product installed.

#### 1.5 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  - 1. Coordinate mockups in this Section with mockups specified in other Sections.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store resilient products and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 90 deg F.

#### 1.7 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive resilient products during the following periods:
  1. 48 hours before installation.
  2. During installation.
  3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F more than 95 deg F.
- C. Install resilient products after other finishing operations, including painting, have been completed.

### PART 2 PRODUCTS

#### 2.1 RESILIENT BASE

- 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 World Industries, Inc.
  2. Burke Mercer Flooring Products; a division of Burke Industries Inc.
  3. Johnsonite; A Tarkett Company.
  4. Roppe Corporation, USA.
- B. Product Standard: ASTM F1861, Type TP (rubber, thermoplastic).
  1. Group: I (solid, homogeneous)
  2. Style and Location:
    - a. Style A, Straight: Provide in areas with carpet.



b. Style B, Cove: Provide in areas with resilient floor coverings.

- C. Thickness: 0.125 inch
- D. Height: 4 inches.
- E. Lengths: Cut lengths 48 inches long or coils in manufacturer's standard length.
- F. Outside Corners: Pre-formed.
- G. Inside Corners: Pre-formed.
- H. Colors: As selected by Architect from full range of industry colors.

## 2.2 RESILIENT MOLDING ACCESSORY

- 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 World Industries, Inc.
  - 2. Burke Mercer Flooring Products; a division of Burke Industries Inc.
  - 3. Johnsonite; A Tarkett Company.
  - 4. Roppe Corporation, USA.
- B. Description: Rubber reducer strips and transition strips for resilient floor coverings.
- C. Locations: Provide rubber molding accessories in areas indicated.
- D. Colors and Patterns: As selected by Architect from full range of industry colors.

## 2.3 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland-cement-based or blended hydraulic-cement-based formulation provided or approved by resilient-product manufacturer for applications indicated.
- B. Adhesives: Water-resistant type recommended by resilient-product manufacturer for resilient products and substrate conditions indicated.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
  1. Installation of resilient products indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Concrete Substrates for Resilient Accessories: Prepare horizontal surfaces according to ASTM F710.
  1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
  2. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.
  3. Alkalinity and Adhesion Testing: Perform tests recommended by manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 10 pH.
  4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
    - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    - b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
- 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 resilient products until materials are the same temperature as space where they are to be installed.
  1. At least 48 hours in advance of installation, move resilient products and installation materials into spaces where they will be installed.
- E. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient products.

### 3.3 RESILIENT BASE INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient base.
- B. Apply resilient base to walls, columns, pilasters, casework and cabinets in toe spaces, and other permanent fixtures in rooms and areas where base is required.
- C. Install resilient base in lengths as long as practical without gaps at seams and with tops of adjacent pieces aligned.
- D. Tightly adhere resilient base to substrate throughout length of each piece, with base in continuous contact with horizontal and vertical substrates.
- E. Do not stretch resilient base during installation.
- F. On masonry surfaces or other similar irregular substrates, fill voids along top edge of resilient base with manufacturer's recommended adhesive filler material.
- G. Preformed Corners: Install preformed corners before installing straight pieces.

### 3.4 RESILIENT ACCESSORY INSTALLATION

- A. Comply with manufacturer's written instructions for installing resilient accessories.
- B. Resilient Molding Accessories: Butt to adjacent materials and tightly adhere to substrates throughout length of each piece. Install reducer strips at edges of floor covering that would otherwise be exposed.

### 3.5 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting resilient products.
- B. Perform the following operations immediately after completing resilient-product installation:
  - 1. Remove adhesive and other blemishes from surfaces.
  - 2. Sweep and vacuum horizontal surfaces thoroughly.
  - 3. Damp-mop horizontal surfaces to remove marks and soil.
- C. Protect resilient products from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Cover resilient products subject to wear and foot traffic until Substantial Completion.

END OF SECTION

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## 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. Vinyl composition tile (VCT) flooring
  - 2. Luxury vinyl tile (LVT) flooring

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For each type of resilient floor tile.
  - 1. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.
  - 2. Show details of special patterns.
- C. Samples: Full-size units of each color, texture, and pattern of floor tile required.
- D. Samples for Initial Selection: For each type of floor tile indicated.
- E. Samples for Verification: Full-size units of each color and pattern of floor tile required.
- F. Product Schedule: For floor tile. Use same designations indicated on Drawings.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

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

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.
  - 1. Engage an installer who employs workers for this Project who are trained or certified by floor tile manufacturer for installation techniques required.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  - 1. Coordinate mockups in this Section with mockups specified in other Sections.
    - a. Size: Minimum 100 sq. ft. for each type, color, and pattern in locations directed by Architect.
  - 2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. 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.

#### 1.9 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 70 deg F or more than 95 deg F, in spaces to receive floor tile during the following periods:
  - 1. 48 hours before installation.
  - 2. During installation.
  - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.

- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.

## PART 2 PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient floor tile, as determined by testing identical products according to ASTM E648 or NFPA 253 by a qualified testing agency.
  - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.

### 2.2 VINYL COMPOSITION TILE (VCT) FLOORING

- A. Basis of Design: Provide products by the manufacturers indicated on the drawings Subject to compliance with requirements, and subject to color and other aesthetic approval at the sole discretion of the Architect, other available manufacturers offering products that may be incorporated into the work include, but are not limited to the following:
  - 1. Armstrong Commercial Flooring
  - 2. Congoleum Corp.
  - 3. Johnsonite
  - 4. Tarkett USA, Inc.
    - a. Style: As indicated in the drawings.
    - b. Module Size: As indicated on the drawings.
    - c. Thickness: Per style indicated on the drawings.
    - d. Flooring Color and Pattern: As selected by Architect from manufacturer's full range.

### 2.3 LUXURY VINYL TILE (LVT) FLOORING

- A. Basis of Design: Provide products by the manufacturers indicated on the drawings Subject to compliance with requirements, and subject to color and other aesthetic approval at the sole discretion of the Architect, other available manufacturers offering products that may be incorporated into the work include, but are not limited to the following:
  - 1. Armstrong Commercial Flooring
  - 2. Congoleum Corp.
  - 3. Interface, Inc.
  - 4. Johnsonite

5. Mannington Commerical
6. Shaw International
7. Tarkett USA, Inc.
  - a. Style: As indicated in the drawings.
  - b. Module Size: As indicated on the drawings.
  - c. Thickness: Per style indicated on the drawings.
  - d. Flooring Color and Pattern: As selected by Architect from manufacturer's full range.

## 2.4 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Latex-modified, Portland-cement-based or blended hydraulic-cement-based formulation provided or approved by floor tile manufacturer for applications indicated. Floor substrates shall be verified. If uneven floor substrates are encountered, leveling materials shall be provided to ensure new floor finishes do not require transitions between similar materials.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.
- C. Seamless-Installation Accessories:
  1. Chemical-Bonding Compound: Manufacturer's product for chemically bonding seams.
- D. Floor Polish: Provide protective, liquid floor-polish products recommended by floor tile manufacturer.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
  1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.



- B. Concrete Substrates: Prepare according to ASTM F710.
  - 1. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
  - 2. Remove substrate coatings and other substances that are incompatible with 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, but not less than 5 or more than 10 pH.
  - 4. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
    - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    - b. Relative Humidity Test: Using in-situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.
- 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 materials are the same temperature as space where they are to be installed.
  - 1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.
- 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.
- 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.

- D. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- E. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- F. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- G. Install floor tiles on covers for telephone and electrical ducts, building expansion-joint covers, and similar items in installation 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 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. Seamless Installation:
  - 1. Chemically Bonded Seams: Bond seams with chemical-bonding compound to fuse sections permanently into a seamless flooring installation. Prepare seams and apply compound to produce tightly fitted seams without gaps, overlays, or excess bonding compound on flooring surfaces.

### 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 surfaces.
  - 2. Sweep and vacuum surfaces thoroughly.
  - 3. Damp-mop surfaces to remove marks and soil.
- C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
- D. Floor Polish: Remove soil, adhesive, and blemishes from floor tile surfaces before applying liquid floor polish.
- E. Joint Sealant: Apply sealant to floor tile perimeter and around columns, at door frames, and at other joints and penetrations.
- F. Sealers and Finish Coats: Remove soil, visible adhesive, and surface blemishes from floor tile surfaces before applying liquid cleaners, sealers, and finish products.

1. Sealer: Apply two base coats of liquid sealer.
  2. Finish: Apply two coats of liquid floor finish.
- G. Cover floor tile until Substantial Completion.

END OF SECTION

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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. Section Includes:
  - 1. Modular carpet tile, including walk off matt carpet tile..

#### 1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at [Project site] .
  - 1. Review methods and procedures related to carpet tile installation including, but not limited to, the following:
    - a. Review delivery, storage, and handling procedures.
    - b. Review ambient conditions and ventilation procedures.
    - c. Review subfloor preparation procedures.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include manufacturer's written data on physical characteristics, durability, and fade resistance.
  - 2. Include manufacturer's written installation recommendations for each type of substrate.
- B. 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.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For carpet tile, for tests performed by a qualified testing agency.

- C. Sample Warranty: For special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For carpet tiles to include in maintenance manuals. Include the following:
  - 1. Methods for maintaining carpet tile, including cleaning and stain-removal products and procedures and manufacturer's recommended maintenance schedule.
  - 2. Precautions for cleaning materials and methods that could be detrimental to carpet tile.

#### 1.7 MAINTENANCE MATERIAL SUBMITTALS

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

#### 1.8 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.
  - 1. Build mockups at locations and in sizes shown on Drawings.
  - 2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Comply with the Carpet and Rug Institute's CRI 104.

#### 1.10 FIELD CONDITIONS

- A. Comply with the Carpet and Rug Institute's CRI 104 for temperature, humidity, and ventilation limitations.
- B. Environmental Limitations: Do not deliver or install carpet tiles until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, and ambient temperature and humidity conditions are maintained at levels planned for building occupants during the remainder of the construction period.

- C. Do not install carpet tiles over concrete slabs until slabs have cured and are sufficiently dry to bond with adhesive and concrete slabs have pH range recommended by carpet tile manufacturer.
- D. Where demountable partitions or other items are indicated for installation on top of carpet tiles, install carpet tiles before installing these items.

#### 1.11 WARRANTY

- A. Special Warranty for Carpet Tiles: Manufacturer agrees to repair or replace components of carpet tile installation that fail in materials or workmanship within specified warranty period.
  - 1. Warranty does not include deterioration or failure of carpet tile due to unusual traffic, failure of substrate, vandalism, or abuse.
  - 2. Failures include, but are not limited to, the following:
    - a. More than ten 10 percent (10%) edge raveling, snags, and runs.
    - b. Dimensional instability.
    - c. Excess static discharge.
    - d. Loss of tuft-bind strength.
    - e. Loss of face fiber.
    - f. Delamination.
  - 3. Warranty Period: Fifteen 15 years from date of Substantial Completion.

### PART 2 PRODUCTS

#### 2.1 CARPET TILE

- A. Carpet Tile (CPT)
  - 1. Basis of Design: Provide products by the manufacturers indicated on the drawings Subject to compliance with requirements, and subject to color and other aesthetic approval at the sole discretion of the Architect, other available manufacturers offering products that may be incorporated into the work include, but are not limited to the following:
    - a. Interface, Inc.
    - b. Mohawk Flooring
    - c. Milliken & Company
    - d. Shaw Industries, Inc.
  - 2. Style: As indicated in the drawings.
  - 3. Module Size: As indicated on the drawings.
  - 4. Thickness: Per style indicated on the drawings.
  - 5. Carpet Color and Pattern: As selected by Architect from manufacturer's full range.
- B. Applied Treatments:

1. Soil-Resistance Treatment: Manufacturer's standard treatment.
2. Antimicrobial Treatment: Manufacturer's standard treatment.

## 2.2 INSTALLATION ACCESSORIES

- A. Trowelable Leveling and Patching Compounds: Latex-modified, hydraulic-cement-based formulation provided or recommended by carpet tile manufacturer. Floor substrates shall be verified. If uneven floor substrates are encountered, leveling materials shall be provided to ensure new floor finishes do not require transitions between similar materials.
- B. Adhesives: Water-resistant, mildew-resistant, non-staining, pressure-sensitive type to suit products and subfloor conditions indicated, that comply with flammability requirements for installed carpet tile, and are recommended by carpet tile manufacturer for releasable installation.
- C. Full adhesive spread. LokDots not acceptable.
- D. Metal Edge/Transition Strips: Extruded aluminum with [mill] finish of profile and width shown, of height required to protect exposed edge of carpet, and of maximum lengths to minimize running joints.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for maximum moisture content, alkalinity range, installation tolerances, and other conditions affecting carpet tile performance.
- B. Examine carpet tile for type, color, pattern, and potential defects.
- C. Concrete Slabs: Verify that finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" and that surfaces are free of cracks, ridges, depressions, scale, and foreign deposits.
  1. Moisture Testing: Perform tests so that each test area does not exceed 200 sq. ft. and perform no fewer than three tests in each installation area and with test areas evenly spaced in installation areas.
    - a. Anhydrous Calcium Chloride Test: ASTM F1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 3 lb of water/1000 sq. ft. in 24 hours.
    - b. Relative Humidity Test: Using in situ probes, ASTM F2170. Proceed with installation only after substrates have a maximum 75 percent relative humidity level measurement.



- c. Perform additional moisture tests recommended in writing by adhesive and carpet tile manufacturers. Proceed with installation only after substrates pass testing.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104 and with carpet tile manufacturer's written installation instructions for preparing substrates indicated to receive carpet tile.
- B. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, depressions, and protrusions in substrates. Fill or level cracks, holes, and depressions 1/8 inch (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. Concrete Substrates: Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, without using solvents. Use mechanical methods recommended in writing by adhesive and carpet tile manufacturers.
- D. Broom and vacuum clean substrates to be covered immediately before installing carpet tile.

### 3.3 INSTALLATION

- A. General: Comply with the Carpet and Rug Institute's CRI 104, Section 10, "Carpet Tile," 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. Maintain pile-direction patterns as directed by the Architect.
- E. 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.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on carpet tile as marked on subfloor. Use nonpermanent, non-staining marking device.

- H. 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 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 the Carpet and Rug Institute's CRI 104, Section 13.7.
- 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

## SECTION 099100 - PAINTING

### PART 1 GENERAL

### PART 2 RELATED DOCUMENTS

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

### PART 3 SUMMARY

- 3.1 Section Includes:
- A. Primers.
  - B. Finish coatings.

### PART 4 ACTION SUBMITTALS

- 4.1 Product Data: For each type of product.
- A. Include preparation requirements and application instructions.
  - B. Indicate VOC content.
- 4.2 Samples: For each type of topcoat product.
- 4.3 Samples for Initial Selection: For each type of topcoat product.
- 4.4 Samples for Verification: For each type of paint system and each color and gloss of topcoat.
- A. Submit Samples on rigid backing, 8 inches square.
  - B. Apply coats on Samples in steps to show each coat required for system.
  - C. Label each coat of each Sample.
  - D. Label each Sample for location and application area.

- 4.5 Product Schedule: Use same designations indicated on Drawings and in the Exterior Painting Schedule to cross-reference paint systems specified in this Section. Include color designations.

#### PART 5 MAINTENANCE MATERIAL SUBMITTALS

- 5.1 Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- A. Paint Products: 5 percent, but not less than 1 gal. of each material and color applied.

#### PART 6 QUALITY ASSURANCE

- 6.1 Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
- A. Architect will select one surface to represent surfaces and conditions for application of each paint system.
1. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft.
  2. Other Items: Architect will designate items or areas required.
- B. Final approval of color selections will be based on mockups.
1. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.
- C. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
- D. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### PART 7 DELIVERY, STORAGE, AND HANDLING

- 7.1 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.
- A. Maintain containers in clean condition, free of foreign materials and residue.
- B. Remove rags and waste from storage areas daily.

#### PART 8 FIELD CONDITIONS

- 8.1 Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.
- 8.2 Do not apply paints in snow, rain, fog, or mist; when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

## PART 9 PRODUCTS

## PART 10 MANUFACTURERS

- 10.1 Source Limitations: Obtain each paint product from single source from single manufacturer.
- 10.2 Products: Subject to compliance with requirements, available products that may be incorporated into the Work include but are not limited to products listed in the Exterior and Interior Painting Schedule for the paint category indicated.
- 10.3 Basis of Design: Provide products by the manufacturers indicated on the drawings Subject to compliance with requirements, and subject to color and other aesthetic approval at the sole discretion of the Architect, other available manufacturers offering products that may be incorporated into the work include, but are not limited to the following:
  - A. Behr Paint Company,
  - B. Benjamin Moore & Co.
  - C. PPG Industries, Inc.
  - D. The Sherwin-Williams Company
  - E. Tnemec Company, Inc.

## PART 11 PAINT PRODUCTS, GENERAL

- 11.1 Material Compatibility:
  - A. 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.

- B. For each coat in a paint system, provide products recommended in writing by topcoat manufacturer for use in paint system and on substrate indicated.
- 11.2 VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for exterior and interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base:
- A. Flat Paints and Coatings: 50 g/L.
  - B. Nonflat Paints and Coatings: 150 g/L.
  - C. Dry-Fog Coatings: 400 g/L.
  - D. Primers, Sealers, and Undercoaters: 200 g/L.
  - E. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
  - F. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
  - G. Pretreatment Wash Primers: 420 g/L.
  - H. Floor Coatings: 100 g/L.
  - I. Shellacs, Clear: 730 g/L.
  - J. Shellacs, Pigmented: 550 g/L.
- 11.3 Colors: As selected by Architect from manufacturer's full range.

## PART 12 EXECUTION

## PART 13 EXAMINATION

- 13.1 Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.
- 13.2 Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:
- A. Concrete: 12 percent.
  - B. Fiber-Cement Board: 12 percent.
  - C. Masonry (Clay and Concrete Masonry Units): 12 percent.
  - D. Wood: 15 percent.

E. Portland Cement Plaster: 12 percent.

F. Gypsum Board: 12 percent.

13.3 Portland Cement Plaster Substrates: Verify that plaster is fully cured.

13.4 Exterior Gypsum Board Substrates: Verify that finishing compound is dry and sanded smooth.

13.5 Verify suitability of substrates, including surface conditions and compatibility, with finishes and primers.

13.6 Proceed with coating application only after unsatisfactory conditions have been corrected.

A. Application of coating indicates acceptance of surfaces and conditions.

#### PART 14 PREPARATION

14.1 Comply with manufacturer's written instructions applicable to substrates and paint systems indicated.

14.2 Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

A. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

14.3 Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

A. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems specified in this Section.

14.4 Concrete Substrates: Remove release agents, curing compounds, efflorescence, and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces to be painted exceeds that permitted in manufacturer's written instructions.

- 14.5 Masonry Substrates: Remove efflorescence and chalk. Do not paint surfaces if moisture content or alkalinity of surfaces or mortar joints exceeds that permitted in manufacturer's written instructions.
- 14.6 Steel Substrates: Remove rust, loose mill scale, and shop primer if any. Clean using methods recommended in writing by paint manufacturer.
- A. SSPC-SP 2.
  - B. SSPC-SP 3.
  - C. SSPC-SP 7/NACE No. 4.
  - D. SSPC-SP 11.
- 14.7 Shop-Primed Steel Substrates: Clean field welds, bolted connections, and areas where shop paint is abraded. Paint exposed areas with the same material as used for shop priming to comply with SSPC-PA 1 for touching up shop-primed surfaces.
- 14.8 Galvanized-Metal Substrates: Remove grease and oil residue from galvanized sheet metal by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
- 14.9 Aluminum Substrates: Remove loose surface oxidation.
- 14.10 Wood Substrates:
- A. Scrape and clean knots. Before applying primer, apply coat of knot sealer recommended in writing by topcoat manufacturer for exterior use in paint system indicated.
  - B. Sand surfaces that will be exposed to view, and remove sanding dust.
  - C. Prime edges, ends, faces, undersides, and backsides of wood.
  - D. After priming, fill holes and imperfections in the finish surfaces with putty or plastic wood filler. Sand smooth when dried.
- 14.11 Plastic Trim Fabrication Substrates: Remove dust, dirt, and other foreign material that might impair bond of paints to substrates.

## PART 15 INSTALLATION

- 15.1 Apply paints in accordance with manufacturer's written instructions.



- A. Use applicators and techniques suited for paint and substrate indicated.
  - B. Paint surfaces behind movable items same as similar exposed surfaces. Before final installation, paint surfaces behind permanently fixed items with prime coat only.
  - C. Paint both sides and edges of exterior doors and entire exposed surface of exterior door frames.
  - D. Paint entire exposed surface of window frames and sashes.
  - E. Do not paint over labels of independent testing agencies or equipment name, identification, performance rating, or nomenclature plates.
  - F. Primers specified in the Exterior Painting Schedule may be omitted on items that are factory primed or factory finished if compatible with intermediate and topcoat coatings and acceptable to intermediate and topcoat paint manufacturers.
- 15.2 If undercoats or other conditions show through topcoat, apply additional coats until cured film has a uniform paint finish, color, and appearance.
- 15.3 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.
- 15.4 Painting Fire Suppression, Plumbing, HVAC, Electrical, Communication, and Electronic Safety and Security Work:
- A. Paint the following work where exposed to view:
    - 1. Uninsulated piping, if installed against painted substrates.
    - 2. Conduit, if installed against painted substrates.

#### PART 16 FIELD QUALITY CONTROL

- 16.1 Dry Film Thickness Testing: Owner may engage the services of a qualified testing and inspecting agency to inspect and test paint for dry film thickness.
- A. Contractor shall touch up and restore painted surfaces damaged by testing.
  - B. If test results show that dry film thickness of applied paint does not comply with paint manufacturer's written instructions, Contractor shall pay for testing and apply additional coats as needed to provide dry film thickness that complies with paint manufacturer's written instructions.

#### PART 17 CLEANING AND PROTECTION

- 17.1 At end of each workday, remove rubbish, empty cans, rags, and other discarded materials from Project site.
  - A. Do not clean equipment with free-draining water and prevent solvents, thinners, cleaners, and other contaminants from entering into waterways, sanitary and storm drain systems, and ground.
  - B. Dispose of contaminants in accordance with requirements of authorities having jurisdiction.
  - C. Allow empty paint cans to dry before disposal.
  - D. Collect waste paint by type and deliver to recycling or collection facility.
- 17.2 After completing paint application, clean spattered surfaces. Remove spattered paints by washing, scraping, or other methods. Do not scratch or damage adjacent finished surfaces.
- 17.3 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.
- 17.4 At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

#### PART 18 EXTERIOR PAINTING SCHEDULE

- 18.1 Concrete Nontraffic Surfaces:
  - A. Latex System:
    - 1. Prime Coat: Primer sealer, latex.
      - a. S-W Loxon Concrete & Masonry Primer Sealer, A24W8300, at 8.0 mils wet, 3.2 mils dry.
    - 2. Intermediate Coat: Latex, exterior, matching topcoat.
    - 3. Topcoat: Latex, exterior, satin.
      - a. S-W A-100 Exterior Latex Satin, A82 Series, at 4.0 mils wet, 1.5 mils dry, per coat.
- 18.2 CMU Substrates:
  - A. Latex System:
    - 1. Block Filler: Block filler, latex, interior/exterior:
      - a. S-W PrepRite Block Filler, B25W25, at 75 to 125 sq. ft. per gal.

2. Intermediate Coat: Latex, exterior, matching topcoat.
3. Topcoat: Latex, exterior, satin.
  - a. S-W A-100 Exterior Latex Satin, A82 Series, at 4.0 mils wet, 1.5 mils dry, per coat.

18.3 Ferrous Metal, Galvanized-Metal, and Aluminum Substrates:

- A. Water-Based Light Industrial Coating System:
  1. Prime Coat: Primer, water based.
    - a. S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series, 5.0 to 10.0 mils wet, 2.0 to 4.0 mils dry.
  2. Intermediate Coat: Light industrial coating, exterior, water based, matching topcoat.
  3. Topcoat: Light industrial coating, exterior, water based, semi-gloss.
    - a. S-W Pro Industrial Acrylic Semi-Gloss Coating, B66-650 Series, at 2.5 to 4.0 mils dry, per coat.

18.4 Wood Substrates: Exposed wood items not indicated to receive shop-applied finish.

- A. Latex System:
  1. Prime Coat: Primer, latex for exterior wood.
    - a. S-W Exterior Latex Primer, B42, at 4.0 mils wet, 1.4 mils dry, per coat.
  2. Intermediate Coat: Latex, exterior, matching topcoat.
  3. Topcoat: Latex, exterior, satin:
    - a. S-W A-100 Exterior Latex Satin, A82 Series, at 4.0 mils wet, 1.5 mils dry, per coat.

18.5 Plastic Trim Fabrication Substrates: Including PVC, plastic, and fiberglass items.

- A. Latex System:
  1. Prime Coat: Primer, bonding, water-based:
    - a. S-W PrepRite ProBlock Latex Primer/Sealer, B57-620 Series, at 4.0 mils wet, 1.4 mils dry.
  2. Intermediate Coat: Latex, exterior, matching topcoat.
  3. Topcoat: Latex, exterior, satin:
    - a. S-W A-100 Exterior Latex Satin, A82 Series, at 4.0 mils wet, 1.5 mils dry, per coat.

18.6 Exterior Gypsum Board Substrates:

- A. Latex System:
  1. Prime Coat: Primer bonding, water-based.

- a. S-W PrepRite ProBlock Latex Primer/Sealer, B57-620 Series, at 4.0 mils wet, 1.4 mils dry.
2. Intermediate Coat: Latex, exterior, matching topcoat.
3. Topcoat: Latex, exterior, semi-gloss.
  - a. S-W Solo Acrylic Semi-Gloss, A76 Series, at 4.0 mils wet, 1.5 mils dry, per coat.

1) INTERIOR PAINTING SCHEDULE

18.7 Concrete Substrates, Nontraffic Surfaces:

- A. Latex System:
  1. Prime Coat: Primer, latex, interior.
    - a. S-W Loxon Concrete & Masonry Primer Sealer, A24W8300, at 8.0 mils wet, 3.2 mils dry.
  2. Intermediate Coat: Latex, interior, matching topcoat.
  3. Topcoat: Latex, interior, eggshell.
    - a. S-W ProMar 200 Zero VOC Latex Egg-Shell, B20-2600 Series, at 4.0 mils wet, 1.7 mils dry, per coat.

18.8 CMU Substrates:

- A. Latex System:
  1. Block Filler: Block filler, latex, interior/exterior:
    - a. S-W PrepRite Block Filler, B25W25, at 75-125 sq. ft. per gal.
  2. Intermediate Coat: Latex, interior, matching topcoat.
  3. Topcoat: Latex, interior, eggshell:
    - a. S-W ProMar 200 Zero VOC Latex Egg-Shell, B20-2600 Series, at 4.0 mils wet, 1.7 mils dry, per coat.

18.9 Metal Substrates (Aluminum, Steel, Galvanized Steel):

- A. Latex System:
  1. Prime Coat: Primer, rust-inhibitive, water based:
    - a. S-W Pro Industrial Pro-Cryl Universal Primer, B66-310 Series, at 5.0 to 10 mils wet, 2.0 to 4.0 mils dry.
  2. Intermediate Coat: Water-based acrylic, interior, matching topcoat.
  3. Topcoat: Water-based acrylic, gloss:
    - a. S-W Pro Industrial Acrylic Gloss Coating, B66-660 Series, at 2.5 to 4.0 mils dry, per coat.

18.10 Wood Substrates: Exposed wood items not indicated to receive shop-applied finish.

- A. Latex System:

1. Prime Coat: Primer sealer, latex, interior:
  - a. S-W PrepRite ProBlock Primer Sealer, B51-620 Series, at 4.0 mils wet, 1.4 mils dry.
2. Intermediate Coat: Latex, interior, matching topcoat.
3. Topcoat: Latex, interior, eggshell:
  - a. S-W ProMar 200 Zero VOC Latex Egg-Shell, B20-2600 Series, at 4.0 mils wet, 1.7 mils dry, per coat.

18.11 Gypsum Board Substrates:

- A. Latex System:
  1. Prime Coat: Primer, latex, interior:
    - a. S-W ProMar 200 Zero VOC Latex Primer, B28W2600, at 4.0 mils wet, 1.0 mils dry.
  2. Intermediate Coat: Latex, interior, matching topcoat.
  3. Topcoat: Latex, interior, eggshell:
    - a. S-W ProMar 200 Zero VOC Latex Egg-Shell, B20-2600 Series, at 4.0 mils wet, 1.7 mils dry, per coat.

END OF SECTION

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## SECTION 101100 - VISUAL DISPLAY UNITS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Visual display board assemblies.
- B. Related Requirements:

#### 1.3 PREINSTALLATION MEETINGS

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

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and accessories for visual display units.
  - 2. Include electrical characteristics for motorized units.
- B. Shop Drawings: For visual display units.
  - 1. Include plans, elevations, sections, details, and attachment to other work.
  - 2. Show locations of panel joints.
  - 3. Show locations and layout of special-purpose graphics.
  - 4. Include sections of typical trim members.
  - 5. Include wiring diagrams for power and control wiring.
- C. Samples for Initial Selection: For each type of visual display unit indicated, for units with factory-applied color finishes, and as follows:
  - 1. Samples of facings for each visual display panel type, indicating color and texture.
  - 2. Fabric swatches of fabric facings for tackboards.
  - 3. Actual factory-finish color samples, applied to aluminum or wood substrates.
  - 4. Include accessory Samples to verify color selected.
- D. Samples: For each type of visual display unit indicated.

1. Visual Display Panel: Not less than 8-1/2 by 11 inches, with facing, core, and backing indicated for final Work. Include one panel for each type, color, and texture required.
  2. Trim: 6-inch long sections of each trim profile.
  3. Accessories: Full-size Sample of each type of accessory.
- E. Product Schedule: For visual display units. Use same designations indicated on Drawings.

## 1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each visual display unit, for tests performed by a qualified testing agency.

## 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver factory-fabricated visual display units completely assembled in one piece. If dimensions exceed maximum manufactured unit size, or if unit size is impracticable to ship in one piece, provide two or more pieces with joints in locations indicated on approved Shop Drawings.

## 1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install visual display units until spaces are enclosed and weathertight, wet-work in spaces is complete and dry, work above ceilings is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

## PART 2 PRODUCTS

### 2.1 VISUAL DISPLAY BOARD ASSEMBLIES

- A. SOURCE LIMITATIONS
  1. Obtain visible display units from single source from single manufacturer.
- B. Visual Display Board Assemblies, General: Factory fabricated.
  1. Corners: Square



2. Width: As indicated on Drawings.
  3. Height: As indicated on Drawings.
  4. Mounting Method: Direct to wall.
- C. Markerboard Panel: Porcelain-enamel-faced markerboard panel on core indicated.
1. Color: White.
- D. Tackboard Panel: Plastic-impregnated-cork tackboard panel on core indicated.
1. Color and Pattern: As selected by Architect from full range of industry colors.
- E. Aluminum Frames and Trim: Fabricated from not less than 0.062-inch thick, extruded aluminum; standard size and shape.
1. Field-Applied Trim: Manufacturer's standard, snap-on or slip-on trim with no visible screws or exposed joints.
  2. Aluminum Finish: Manufacturer's standard baked-enamel or powder-coat finish.
    - a. Color: As selected by Architect from full range of industry colors and color densities.
- F. Joints: Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Architect.
- G. Marker Trays: Manufacturer's standard; continuous, for markerboards only.
1. Box Type: Extruded aluminum with slanted front, grooved tray, and cast-aluminum end closures.

## 2.2 MARKERBOARD PANELS

- A. Porcelain-Enamel Markerboard Panels: Balanced, high-pressure, factory-laminated markerboard assembly of three-ply construction, consisting of moisture-barrier backing, core material, and porcelain-enamel face sheet with low-gloss finish. Laminate panels under heat and pressure with manufacturer's standard, flexible waterproof adhesive.
1. Manufacturer's Standard Core: Minimum 1/4 inch thick, with manufacturer's standard moisture-barrier backing.
  2. Laminating Adhesive: Manufacturer's standard moisture-resistant thermoplastic type.

## 2.3 TACKBOARD PANELS

- A. Tackboard Panels:
1. Facing: Plastic-impregnated cork
  2. Core: Manufacturer's standard.

## 2.4 MATERIALS

- A. Porcelain-Enamel Face Sheet: PEI-1002, with face sheet manufacturer's standard two- or three-coat process.
- B. Plastic-Impregnated-Cork Sheet: Seamless, homogeneous, self-sealing sheet consisting of granulated cork, linseed oil, resin binders, and dry pigments that are mixed and calendared onto fabric backing; with washable vinyl finish and integral color throughout.
- C. Hardboard: ANSI A135.4, tempered.
- D. Particleboard: ANSI A208.1, Grade M-1.
- E. MDF: ANSI A208.2, Grade 130.
- F. Fiberboard: ASTM C208 cellulosic fiber insulating board.
- G. Clear Tempered Glass: ASTM C1048, Kind FT, Condition A, Type I, Class 1, Quality Q3, with exposed edges seamed before tempering.
- H. Extruded Aluminum: ASTM B221, Alloy 6063.
- I. Adhesives for Field Application: Mildew-resistant, nonstaining adhesive for use with specific type of panels, sheets, or assemblies; and for substrate application; as recommended in writing by visual display unit manufacturer.

## 2.5 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM/NOMMA 500 for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## 2.6 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
- B. Baked-Enamel or Powder-Coat Finish: AAMA 2603, except with a minimum dry film thickness of 1.5 mils. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances, surface conditions of wall, and other conditions affecting performance of the Work.
- B. Examine roughing-in for electrical power systems to verify actual locations of connections before installation of motorized, sliding visual display units.
- C. Examine walls and partitions for proper preparation and backing for visual display units.
- D. Examine walls and partitions for suitable framing depth where sliding visual display units will be installed.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Comply with manufacturer's written instructions for surface preparation.
- B. Clean substrates of substances, such as dirt, mold, and mildew, that could impair the performance of and affect the smooth, finished surfaces of visual display boards.
- C. Prepare surfaces to achieve a smooth, dry, clean surface free of flaking, unsound coatings, cracks, defects, projections, depressions, and substances that will impair bond between visual display units and wall surfaces.
- D. Prime wall surfaces indicated to receive visual display units as recommended in writing by primer/sealer manufacturer and visual display unit manufacturer.
- E. Prepare recesses for sliding visual display units as required by type and size of unit.

### 3.3 INSTALLATION

- A. General: Install visual display surfaces in locations and at mounting heights indicated on Drawings, or if not indicated, at heights indicated below. Keep perimeter lines straight, level, and plumb. Provide grounds, clips, backing materials, adhesives, brackets, anchors, trim, and accessories necessary for complete installation.
- B. Field-Assembled Visual Display Board Assemblies: Coordinate field-assembled units with grounds, trim, and accessories indicated. Join parts with a neat, precision fit.
  - 1. Make joints only where total length exceeds maximum manufactured length. Fabricate with minimum number of joints, balanced around center of board, as acceptable to Architect.

2. Where size of visual display board assemblies or other conditions require support in addition to normal trim, provide structural supports or modify trim as indicated or as selected by Architect from manufacturer's standard structural support accessories to suit conditions indicated.
- C. Factory-Fabricated Visual Display Board Assemblies: Adhere to wall surfaces with adhesive gobs at 16 inches o.c., horizontally and vertically.
- D. Factory-Fabricated Visual Display Board Assemblies: Attach concealed clips, hangers, and grounds to wall surfaces and to visual display board assemblies with fasteners at not more than 16 inches o.c. Secure tops and bottoms of boards to walls.
- E. Visual Display Board Assembly Mounting Heights: Install visual display units at mounting heights indicated on Drawings.

#### 3.4 CLEANING AND PROTECTION

- A. Clean visual display units in accordance with manufacturer's written instructions. Attach one removable cleaning instructions label to visual display unit in each room.
- B. Touch up factory-applied finishes to restore damaged or soiled areas.
- C. Cover and protect visual display units after installation and cleaning.

END OF SECTION

## SECTION 101423 - INTERIOR PANEL SIGNAGE

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Panel signs.
- B. Related Requirements:

#### 1.3 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.

#### 1.4 COORDINATION

- A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.
- B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For panel signs.
  - 1. Include fabrication and installation details and attachments to other work.
  - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
  - 3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
- C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
  - 1. Include representative Samples of available typestyles and graphic symbols.

- D. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
  - 1. Panel Signs: Full-size Sample.
  - 2. Variable Component Materials: Full-size Sample of each base material, character (letter, number, and graphic element) in each exposed color and finish not included in Samples above.
  - 3. Exposed Accessories: Full-size Sample of each accessory type.
  - 4. Full-size Samples, if approved, will be returned to Contractor for use in Project.
- E. Product Schedule: For panel signs. Use same designations indicated on Drawings or specified.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Sample Warranty: For special warranty.

#### 1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For signs to include in maintenance manuals.

#### 1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials, from the same product run, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Tools: One set of specialty tools for assembling signs and replacing variable sign components.

#### 1.9 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer of products.

#### 1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Deterioration of finishes beyond normal weathering.
    - b. Deterioration of embedded graphic image.
    - c. Separation or delamination of sheet materials and components.
  - 2. Warranty Period: Five years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 PANEL SIGNS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Best Sign Systems, Inc. or a comparable product by one of the following:
1. ACE Sign Systems, Inc.
  2. Advance Corporation; Braille-Tac Division.
  3. Allen Industries Architectural Signage.
  4. Allenite Signs; Allen Marking Products, Inc.
  5. APCO Graphics, Inc.
  6. ASI-Modulex, Inc.
  7. Bunting Graphics, Inc.
  8. Fossil Industries, Inc.
  9. Gemini Incorporated.
  10. Grimco, Inc.
  11. Innerface Sign Systems, Inc.
  12. InPro Corporation
  13. Matthews International Corporation; Bronze Division.
  14. Mills Manufacturing Company.
  15. Mohawk Sign Systems.
  16. Nelson-Harkins Industries.
  17. Seton Identification Products.
  18. Signature Signs, Incorporated.
  19. Supersine Company (The).
- B. Interior Panel Signs: Provide smooth sign panel surfaces constructed to remain flat under installed conditions within a tolerance of plus or minus 1/16 inch (1.5 mm) measured diagonally from corner to corner, complying with the following requirements:
1. Acrylic Sheet: 0.125 inch (3.175 mm) thick.
  2. PVC Sheet: 0.125 inch (3.175 mm) thick, extruded, high-impact PVC plastic.
  3. Laminated Sheet: High-pressure engraved stock with face laminated to acrylic core in finishes and color combinations indicated.
  4. Edge Condition: Beveled.
  5. Corner Condition: Rounded to 3/8 inch (9.52 mm).
  6. Mounting: Unframed.
    - a. Ceiling Projection mounted with two-face tape.
    - b. Manufacturer's standard anchors for substrates encountered.
  7. Custom Paint Colors: Match Pantone color matching system.
  8. Color: As selected by Architect from manufacturer's full range.

9. Tactile Characters: Characters and Grade 2 Braille raised 1/32 inch (0.8 mm) above surface.
  10. Lettering: Raised 1/32 inch (0.80 mm) integral with panel material. White melamine surface.
    - a. Font Type: To Be Selected by Architect from Standard Fonts
    - b. Size: As indicated.
  11. Sizes and Types: Refer to signage information on drawings.
  12. Text and Quantities of Signs: Refer to signage information on drawings.
  13. Flame Spread Classification: Class A Finish – flame spread 0-25; any material classified at 25 or less, and any element thereof which, when so tested, shall not continue to propagate fire.
- C. Changeable Message Inserts: Fabricate signs to allow insertion of changeable messages in the form of transparent covers with paper inserts printed by Owner.
1. Furnish insert material and software for creating text and symbols for PC-Windows computers for Owner production of paper inserts.
  2. Furnish insert material cut-to-size for changeable message insert.
- D. Colored Coatings for Acrylic Sheet: For copy and background colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and are UV and water resistant for five years for application intended.

## 2.2 PANEL-SIGN MATERIALS

- A. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).
- B. Fiberglass Sheet: Multiple laminations of glass-fiber-reinforced polyester resin with UV-light stable, colorfast, nonfading, weather- and stain-resistant, colored polyester gel coat, and with manufacturer's standard finish.
- C. Polycarbonate Sheet: ASTM C1349, Appendix X1, Type II (coated, mar-resistant, UV-stabilized polycarbonate), with coating on both sides.
- D. PVC Sheet: Manufacturer's standard, UV-light stable, PVC plastic.
- E. Vinyl Film: UV-resistant vinyl film of nominal thickness indicated, with pressure-sensitive, permanent adhesive on back; die cut to form characters or images as indicated on Drawings and suitable for exterior applications.
- F. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

## 2.3 ACCESSORIES



- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following unless otherwise indicated:
  - 1. Use concealed fasteners and anchors unless indicated to be exposed.
  - 2. For exterior exposure, furnish hot-dip galvanized devices unless otherwise indicated.
  - 3. Exposed Metal-Fastener Components, General:
    - a. Fabricated from same basic metal and finish of fastened metal unless otherwise indicated.
    - b. Fastener Heads: For nonstructural connections, use flathead screws and bolts with tamper-resistant slots unless otherwise indicated.
  - 4. Sign Mounting Fasteners:
    - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly unless otherwise indicated.
    - b. Projecting Studs: Threaded studs with sleeve spacer, welded or brazed to back of sign material or screwed into back of sign assembly, unless otherwise indicated.
    - c. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, and installed in predrilled holes.
- B. Adhesive: As recommended by sign manufacturer.
- C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch, with adhesive on both sides.
- D. Hook-and-Loop Tape: Manufacturer's standard two-part tape consisting of hooked part on sign back and looped side on mounting surface.
- E. Magnetic Tape: Manufacturer's standard magnetic tape with adhesive on one side.

## 2.4 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
  - 1. Preassemble signs in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
  - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.

3. Comply with AWS for recommended practices in welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed connections of flux, and dress exposed and contact surfaces.
  4. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
  5. Internally brace signs for stability, to meet structural performance loading without oil-canning or other surface deformation, and for securing fasteners.
  6. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.
- B. Surface-Engraved Graphics: Machine engrave characters and other graphic devices into indicated sign surface to produce precisely formed copy, incised to uniform depth.
1. Engraved Metal: Fill engraved graphics with manufacturer's standard baked enamel.
  2. Engraved Opaque Acrylic Sheet: Fill engraved graphics with manufacturer's standard enamel.
  3. Face-Engraved Clear Acrylic Sheet: Fill engraved copy with manufacturer's standard enamel. Apply manufacturer's standard opaque background color coating to back face of acrylic sheet.
  4. Engraved Plastic Laminate: Engrave through exposed face ply of plastic-laminate sheet to expose contrasting core ply.
- C. Subsurface-Applied Graphics: Apply graphics to back face of clear face-sheet material to produce precisely formed image. Image shall be free of rough edges.
- D. Subsurface-Engraved Graphics: Reverse engrave back face of clear face-sheet material. Fill resulting copy with manufacturer's standard enamel. Apply opaque manufacturer's standard background color coating over enamel-filled copy.
- E. Shop- and Subsurface-Applied Vinyl: Align vinyl film in final position and apply to surface. Firmly press film from the middle outward to obtain good bond without blisters or fishmouths.
- F. Signs with Changeable Message Capability: Fabricate signs to allow insertion of changeable messages as follows:
1. For snap-in changeable inserts beneath removable face sheet, furnish one suction or other device to assist in removing face sheet. Furnish initial changeable insert. Furnish two blank inserts for each sign for Owner's use.
  2. For slide-in changeable inserts, fabricate slot without burrs or constrictions that inhibit function. Furnish initial changeable insert. Furnish two blank inserts for each sign for Owner's use.

3. For frame to hold changeable sign panel, fabricate frame without burrs or constrictions that inhibit function. Furnish initial sign panel. Subsequent changeable sign panels are by Owner.
- G. Brackets: Fabricate brackets, fittings, and hardware for bracket-mounted signs to suit sign construction and mounting conditions indicated. Modify manufacturer's standard brackets as required.
  1. Stainless-Steel Brackets: Factory finish brackets to match sign background finish unless otherwise indicated.

## 2.5 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- C. Directional Finishes: Run grain with long dimension of each piece and perpendicular to long dimension of finished trim or border surface unless otherwise indicated.
- D. Organic, Anodic, and Chemically Produced Finishes: Apply to formed metal after fabrication but before applying contrasting polished finishes on raised features unless otherwise indicated.

## 2.6 ACRYLIC SHEET FINISHES

- A. Colored Coatings for Acrylic Sheet: For copy and background colors, provide colored coatings, including inks, dyes, and paints, that are recommended by acrylic manufacturers for optimum adherence to acrylic surface and that are UV and water resistant for five years for application intended.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify that sign-support surfaces are within tolerances to accommodate signs without gaps or irregularities between backs of signs and support surfaces unless otherwise indicated.

- C. Verify that anchorage devices embedded in permanent construction are correctly sized and located to accommodate signs.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
  - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
  - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
  - 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
  - 4. Corrosion Protection: Coat concealed surfaces of exterior aluminum in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.
- B. Accessible Signage: Install in locations on walls as indicated on Drawings and [according to the accessibility standard.
- C. Mounting Methods:
  - 1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
    - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
  - 2. Projecting Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.
    - a. Masonry Substrates: Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place spacers on studs, place sign in position, and push until spacers are pinched between sign and substrate, embedding the stud ends in holes. Temporarily support sign in position until adhesive fully sets.
    - b. Thin or Hollow Surfaces: Place spacers on studs, place sign in position with spacers pinched between sign and substrate, and install washers and nuts on stud ends projecting through opposite side of surface, and tighten.
  - 3. Through Fasteners: Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
  - 4. Brackets: Remove loose debris from substrate surface and install backbar or bracket supports in position so that signage is correctly located and aligned.

5. Adhesive: Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
  6. Two-Face Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position and push to engage tape adhesive.
  7. Hook-and-Loop Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply sign component of two-part tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage; push to engage tape adhesive. Keep tape strips 0.250 inch from edges to prevent visibility at sign edges when sign is initially installed or reinstalled. Apply substrate component of tape to substrate in locations aligning with tape on back of sign; push and rub well to fully engage tape adhesive to substrate.
  8. Magnetic Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position.
  9. Shim-Plate Mounting: Provide 1/8-inch thick, concealed aluminum shim plates with predrilled and countersunk holes, at locations indicated, and where other direct mounting methods are impractical. Attach plate with fasteners and anchors suitable for secure attachment to substrate.
- D. Field-Applied, Vinyl-Character Signs: Clean and dry substrate. Align sign characters in final position before removing release liner. Remove release liner in stages and apply and firmly press characters into final position. Press from the middle outward to obtain good bond without blisters or fishmouths. Remove carrier film without disturbing applied vinyl film.
- E. Signs Mounted on Glass: Provide opaque sheet matching sign material and finish onto opposite side of glass to conceal back of sign.

### 3.3 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.

ON COMPLETION OF INSTALLATION, CLEAN EXPOSED SURFACES OF SIGNS ACCORDING TO MANUFACTURER'S WRITTEN INSTRUCTIONS AND TOUCH UP MINOR NICKS AND ABRASIONS IN FINISH. MAINTAIN SIGNS IN A CLEAN CONDITION DURING CONSTRUCTION AND PROTECT FROM DAMAGE UNTIL ACCEPTANCE BY OWNER.

END OF SECTION

## SECTION 102123 - CUBICLE CURTAINS AND TRACK

### TIPS:

TO VIEW NON-PRINTING EDITOR'S NOTES THAT PROVIDE GUIDANCE FOR EDITING, CLICK ON MASTERWORKS/SINGLE-FILE FORMATTING/TOGGLE/EDITOR'S NOTES.

TO READ DETAILED RESEARCH, TECHNICAL INFORMATION ABOUT PRODUCTS AND MATERIALS, AND COORDINATION CHECKLISTS, CLICK ON MASTERWORKS/SUPPORTING INFORMATION.

### PART 1 GENERAL

#### 4.1 RELATED DOCUMENTS

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

#### 4.2 SUMMARY

- A. Section Includes:
  - 1. Cubicle-curtain tracks and carriers..
  - 2. Cubicle curtains..
- B. Related Requirements:
  - 1. [Section 061000 "Rough Carpentry"] [Section 061053 "Miscellaneous Rough Carpentry"] for supplementary wood framing and blocking for mounting items requiring anchorage.
  - 2. Section 092216 "Non-Structural Metal Framing" for supplementary metal framing and blocking for mounting items requiring anchorage.

#### 4.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. For each type of curtain fabric indicated, include durability, laundry temperature limits, fade resistance, applied curtain treatments, and fire-test-response characteristics.
- B. Shop Drawings: For curtains and tracks.
  - 1. Show layout and types of cubicles, sizes of curtains, number of carriers, anchorage details, and conditions requiring accessories. Indicate dimensions taken from field measurements.

2. Include details of blocking for track support.
- C. Samples: For each exposed product and for each color and texture specified, 10 inches (254 mm) in size.
- D. Samples for Initial Selection: For each type of curtain material indicated.
- E. Samples for Verification: For each type of product required, prepared on Samples of size indicated below:
  1. Curtain Fabric: Not less than 10 inches (254 mm) square and showing complete pattern repeat, from dye lot used for the Work, with specified treatments applied. Mark top and face of material.
  2. Mesh Top: Not less than 10 inches (254 mm) square.
  3. Curtain Track: Not less than 10 inches (254 mm) long.
  4. Curtain Carrier: Full-size unit.
- F. Product Schedule: For curtains and tracks.[ Use same designations indicated on Drawings].

#### 4.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For curtains, tracks, and hardware to include in operation and maintenance manuals.

#### 4.5 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. Curtain Carriers and Track End Caps: Full-size units equal to [3] percent (3%) of amount installed for each size indicated, but no fewer than ten (10)[10] units.
  2. Curtains: Onone (1) fFull-size units equal. to [10] percent of amount installed for each size indicated, but no fewer than [two] units.

#### 4.6 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
  1. Build mockup of typical cubicle as shown on Drawings[ as part of patient-room mockup].
  2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.



## PART 2 PRODUCTS

### 5.1 PERFORMANCE REQUIREMENTS

- A. Cubicle Curtains: Provide curtain fabrics with the following characteristics:
1. Laundering: Launderable to a water temperature of not less than [160 deg F (71 deg C)] .
  2. Flame Resistance: Provide fabrics identical to those that have passed NFPA 701 when tested by a qualified testing agency acceptable to authorities having jurisdiction.
    - a. Identify fabrics with appropriate markings of a qualified testing agency.

### 5.2 CUBICLE-CURTAIN SUPPORT SYSTEMS

- A.
- B. Extruded-Aluminum Curtain Track: Not less than [1-1/4 inches wide by 3/4 inch high (32 mm wide by 19 mm high)] [5/8- inch wide by 1/2 -inch high (16 mm wide by 13 mm high)].
1. Track Minimum Wall Thickness: [0.050 inch (1.27 mm)] [0.058 inch (1.47 mm)] [0.062 inch (1.57 mm)] [Manufacturer's standard] .
  2. Curved Track: Factory-fabricated, [12-inch- (305-mm-)] radius bends.
  3. Finish: [Clear anodized] [Satin anodized] [Baked enamel, acrylic, or epoxy] .
- C. PVC Curtain Track: Not less than 1-1/4 inches wide by 15/16 inch high (32 mm wide by 24 mm high).
1. Curved Track: Factory-fabricated, 12-inch- (305-mm-) radius bends.
- D. Curtain Track Accessories: Fabricate splices, end caps, connectors, end stops, coupling and joining sleeves, wall flanges, brackets, ceiling clips, and other accessories from same material and with same finish as track.
1. Suspended-Track Support: Not less than [5/8-inch- (16-mm-) square] [7/8-inch- (22.2-mm-) OD] tube.
  2. End Stop:: [Nonremovable] [Removable with carrier hook].
  3. Switch Unit: Shuttle and coupling device for rerouting and securing cubicle curtain, with pull chain for switching track.
- E. Curtain Roller Carriers: Two (2) nylon rollers and nylon axle with [chrome-plated steel] [nylon] [aluminum] hook.
- F. Curtain Glide Carriers: One-piece nylon glide with [chrome-plated steel] [nylon] hook.
- G. Breakaway Curtain Carriers:: [One-piece nylon] [Velcro] breakaway curtain carriers designed to allow curtains to detach from tracks with a pulling force of no more than 5 lbf (22.2 N).

- H. Exposed Fasteners: Stainless steel.
- I. Concealed Fasteners: [Hot-dip galvanized] [Stainless steel].

### 5.3 CURTAINS

- A.
- B. Fabric and Color: Curtain manufacturer's standard, one hundred 100 percent (100%) polyester; inherently and permanently flame resistant, stain resistant, and antimicrobial.
  - 1. Manufacturer: Refer to drawings. Proprietary Fiber:
    - a.
  - 2. Pattern: .
  - 3. Width: .
  - 4. Color, Pattern:, Manufacturer:: As selected by Architect from manufacturer's full range. Refer to Material Legend on drawing AF001. [As selected by Architect from manufacturer's full range] .
- C. Curtain Grommets: : Two-piece, rolled-edge, rustproof, nickel-plated brass; spaced not more than 6 inches (152 mm) on center.c.; machined into top hem.
- D. Mesh Top: Not less than [20-inch- (508-mm-)] [22-inch- (559-mm-)] high mesh top.
  - 1. Mesh: No. [50] [40] [42] nylon mesh.
- E. Beaded-Chain Curtain Drop: [6 inches (152 mm)] [9 inches (229 mm)] [12 inches (305 mm)] [15 inches (381 mm)] [18 inches (457 mm)] long; nickel-plated steel with aluminum hook.
- F. PVC-Strip Curtain Drop: [16 inches (406 mm)] [18 inches (457 mm)] long with chrome-plated steel hook.
- G. Snap Attachments: Provide manufacturer's standard nickel-plated brass snap attachments for modular panels.
- H. Curtain Tieback: Nickel-plated brass chain; one at each curtain termination.

### 5.4 CURTAIN FABRICATION

- A. Continuous Curtain Panels:
  - 1. Width: Equal to track length from which curtain is hung plus 10 percent of added fullness, but not less than 12 inches (305 mm) of added fullness.
  - 2. Length: Equal to floor-to-ceiling height, minus depth of track and carrier at top, and minus clearance above the finished floor of [12 inches (305 mm)] [15 inches (381 mm)] [As indicated on Drawings] .

3. Top Hem: Not less than 1 inch (25.4 mm) and not more than 1-1/2 inches (38 mm) wide, triple thickness, reinforced with integral web, and double lock-stitched.
  4. Mesh Top: Top hem of mesh not less than 1 inch (25.4 mm) and not more than 1-1/2 inches (38 mm) wide, triple thickness, reinforced with integral web, and double lock-stitched. Double lockstitch bottom of mesh directly to 1/2-inch (13-mm) triple thickness, top hem of curtain fabric.
  5. Bottom Hem: Not less than 1 inch (25.4 mm) and not more than 1-1/2 inches (38 mm) wide, [double thickness and single] [double thickness and double] [triple thickness, reinforced, and double] lock-stitched.
  6. Side Hems: Not less than 1/2 inch (13 mm) and not more than 1-1/4 inches (32 mm) wide, with [double] [triple] turned edges, and single lock-stitched.
  7. Vertical Seams: Not less than 1/2 inch (13 mm) wide, double- turned, and double- stitched.
- B. Modular Curtain Panels:
1. Fabric Panels: [48 inches (1219 mm)] [66 inches (1676 mm)] wide. Fabricate panels in quantity required to provide assembled curtains equal to track lengths plus 10 percent added fullness, but not less than 12 inches (305 mm) added fullness.
    - a. Top Hem: Not less than 1 inch (25.4 mm) and not more than 1-1/2 inches (38 mm) wide, triple thickness, reinforced with integral web, double lockstitched, and with snap attachments to attach panels to mesh top.
    - b. Side Hems: Not less than 1/2 inch (13 mm) and not more than 1-1/4 inches (32 mm) wide, with double turned edges, single lockstitched, and [designed for panels hung with overlapping side hems for privacy] [with snap attachments to attach one panel to another].
  2. Length: Equal to floor-to-ceiling height, minus depth of track and carrier at top, and minus clearance above the finished floor of [12 inches (305 mm)] [15 inches (381 mm)] [As indicated on Drawings] .
  3. Mesh Top: Top hem of mesh not less than 1 inch (25.4 mm) and not more than 1-1/2 inches (38 mm) wide, triple thickness, reinforced with integral web, and double lockstitched.
    - a. Type: [Continuous for each track length, matching overall width of assembled curtains] [Modular, matching width of modular fabric panels with snap attachments at side hems of mesh-top panels].
  4. Vertical Seams: Not less than 1/2 inch (13 mm) wide, double turned and double stitched.

## PART 3 EXECUTION

### 6.1 EXAMINATION

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

## 6.2 INSTALLATION

- A. Install tracks level and plumb, according to manufacturer's written instructions.
- B. For tracks of up to 20 feet (6.0 m) in length, provide track fabricated from single, continuous length.
  - 1. Curtain-Track Mounting: [Surface] [Suspended] [As indicated on Drawings].
- C. Surface-Track Mounting: Fasten tracks to ceilings at intervals recommended by manufacturer. Fasten tracks to structure at each splice and tangent point of each corner. Center fasteners in track to ensure unencumbered carrier operation. Attach track to ceiling as follows:
  - 1. Mechanically fasten directly to bottom of concrete deck with post-installed anchors.
  - 2. Mechanically fasten directly to finished ceiling with toggle bolts.
  - 3. Mechanically fasten to furring through suspended ceiling with screw and tube spacer.
  - 4. Mechanically fasten to suspended ceiling grid with screws.
  - 5. Attach track to suspended ceiling grid with manufacturer's proprietary clip.
- D. Suspended-Track Mounting: Install track with manufacturer's standard tubular aluminum suspended supports at intervals and with fasteners recommended by manufacturer. Fasten supports to structure. Provide supports at each splice and tangent point of each corner. Secure ends of track to wall with flanged fittings or brackets.
- E. Track Accessories: Install splices, end caps, connectors, end stops, coupling and joining sleeves, and other accessories as required for a secure and operational installation.
  - 1. Provide one locking switch unit for each pair of beds.
  - 2. Provide one hinged loading unit for each [bed] [pair of beds with locking switch unit].
- F. Curtain Carriers: Provide curtain carriers adequate for 6-inch (152-mm) spacing along full length of curtain plus an additional carrier.
- G. Cubicle Curtains: Hang curtains on each curtain track.[ Secure with curtain tieback.]

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## SECTION 102641 - BULLET RESISTANT PANELS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section includes security glass for the following applications:
  - 1. Bullet resistant panels rated for all ballistic levels.

#### 1.3 REFERENCES

- A. ASTM International (ASTM):
  - 1. ASTM E 84 - Test method for the Surface Burning Characteristics of Building Materials.
  - 2. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
  - 3. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
  - 4. ASTM E 413 - Classification for Rating Sound Insulation.
  - 5. ASTM F 1233 - Standard Test Method for Security Glazing Materials and Systems.
  - 6. ASTM E 1332 - Standard Classification for Rating Outdoor-Indoor Sound Attenuation.
- B. National Institute of Justice Ballistic Standards (NIJ):
  - 1. NIJ Standard 0108.01 - (National Institute of Justice) Standard for Ballistic Resistant Protective Materials.
- C. Underwriters Laboratories (UL):
  - 1. UL 752 Specifications and Ammunition, 11th Edition, Standard for Bullet Resisting Equipment published September 9, 2005, revised December 21, 2006.
  - 2. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
  - 3. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
  - 4. ASTM E 413 - Classification for Rating Sound Insulation.
  - 5. ASTM F 1233 - Standard Test Method for Security Glazing Materials and Systems.

6. ASTM E 1332 - Standard Classification for Rating Outdoor-Indoor Sound Attenuation.

- D. Glazing Manufacturers: Firms that produce primary glass, monolithic plastic glazing, or fabricated security glazing, as defined in referenced glazing publications.
- E. Interspace: Space between lites of air-gap security glazing or insulating security glazing.

1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on security glazing, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
  - 2. Review temporary protection requirements for security glazing during and after installation.

1.6 ACTION SUBMITTALS

- A. Product Data: Manufacturer's data sheets on each product to be used, includingFor each type of product.:

PART 2 PREPARATION INSTRUCTIONS AND RECOMMENDATIONS.

PART 3 STORAGE AND HANDLING REQUIREMENTS AND RECOMMENDATIONS.

3.1 Installation methods.

SHOP DRAWINGS:

- 4.1 Submit shop drawings prepared by the manufacturer showing plans, sections, elevations, layouts, profiles and product component locations, including anchorage, bracing, fasteners, accessories and finishes.
- 4.2 Include dimensioned elevation of each type opening assembly in project; indicate sizes and locations of hardware, and lites if specified.



- 4.3 Schedule: Indicate each opening assembly in project; cross-referenced to plans, elevations, and details.

PART 4 DESIGN DATA: BULLET RESISTANCE ANALYSIS DESIGN CALCULATIONS FOR SPECIFIC PROJECT CONDITIONS, CERTIFYING SYSTEM CONFORMANCE TO SPECIFIED PERFORMANCE REQUIREMENTS.

- 5.1 UL Listing Verification and UL752 Current Test Results as provided by Underwriters Laboratories.  
1. ASTM E 84

PART 5 ASTM E 90.

- 6.1 ASTM E 119.

PART 6 ASTM E 413.

- 7.1 ASTM F 1233.  
1. ASTM E 1332.

- B. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.

PART 7 SAMPLES FOR VERIFICATION SAMPLES: FOR EACH FINISH PRODUCT SPECIFIED, TWO SAMPLES, MINIMUM SIZE 6 INCHES SQUARE REPRESENTING ACTUAL PRODUCT, COLOR, AND PATTERNS.

- 8.1 Security Glazing Samples: For each type of security glazing; 12 inches (300 mm) square.
- A. Glazing Accessory Samples: For sealants and colored spacers, in 12 inch (300 mm) lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
  - B. Security Glazing Schedule: List security glazing types and thicknesses for each size opening and location. Use same designations indicated on Drawings. Indicate coordinated dimensions of security glazing and construction that receives security glazing, including clearances and glazing channel dimensions.
  - C. Delegated-Design Submittal: For security glazing indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

## 8.2 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For installers, manufacturers, and testing agencies.
- B. Product Certificates: For each type of product indicated, from manufacturer.
- C. Product Test Reports: For each type of security glazing, for tests performed by a qualified testing agency.
- D. Product Test Reports: For each type of glazing sealant, for tests performed by a qualified testing agency.
  - 1. Provide test reports based on testing current sealant formulations within previous 36-month period.
- E. Preconstruction adhesion and compatibility test reports.
- F. Sample Warranties: For special warranties.

## 8.3 QUALITY ASSURANCE

PART 8 MANUFACTURER QUALIFICATIONS: COMPANY SPECIALIZING IN MANUFACTURING PRODUCTS OF THE TYPE SPECIFIED WITH A MINIMUM DOCUMENTED EXPERIENCE OF FIVE YEARS.

- 9.1 Installer Qualifications: Company specializing in installation of products specified with minimum three years documented experience.

PART 9 COORDINATION OF WORK: COORDINATE LAYOUT AND INSTALLATION OF COMPONENTS WITH OTHER CONSTRUCTION SUPPORTED BY, OR PENETRATING THROUGH, CEILINGS, INCLUDING LIGHT FIXTURES, HVAC EQUIPMENT, FIRE-SUPPRESSION SYSTEM, AND PARTITIONS.

- 10.1 Installer Qualifications: A qualified installer who employs glazing installers for this Project who are certified under the National Glass Association Glazier Certification Program.
  - A. Security Glazing Testing Agency Qualifications: Subject to compliance with requirements, testing agency is one of the following:
    - 1. H. P. White Laboratory, Inc.
    - 2. Underwriters Laboratories, Inc.
    - 3. Wiss, Janney, Elstner Associates, Inc.
  - B. Sealant Testing Agency Qualifications: Qualified according to ASTM C1021 for testing indicated.

## 10.2 PRECONSTRUCTION TESTING

- A. Preconstruction Adhesion and Compatibility Testing: Test each security glazing type, tape sealant, gasket, glazing accessory, and glazing-framing member for adhesion to and compatibility with elastomeric glazing sealants.
1. Testing will not be required if data based on previous testing of current sealant products and glazing materials match those submitted.
  2. Use ASTM C1087 to determine whether priming and other specific joint-preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to security glazing, tape sealants, gaskets, and glazing channel substrates.
  3. Test no fewer than eight Samples of each type of material, including joint substrates, shims, sealant backings, secondary seals, and miscellaneous materials.
  4. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
  5. For materials failing tests, submit sealant manufacturer's written instructions for corrective measures, including the use of specially formulated primers.

## 10.3 DELIVERY, STORAGE, AND HANDLING

PART 10 DELIVER AND STORE PRODUCTS IN MANUFACTURER'S UNOPENED PACKAGING BEARING THE BRAND NAME AND MANUFACTURER'S IDENTIFICATION UNTIL READY FOR INSTALLATION.

PART 11 DELIVER MATERIALS TO PROJECT WITH MANUFACTURER'S UL LISTED LABELS INTACT AND LEGIBLE.

PART 12 HANDLE MATERIAL WITH CARE TO PREVENT DAMAGE. STORE MATERIALS INSIDE UNDER COVER, STACK FLAT AND OFF THE FLOOR.

- 13.1 Protect security glazing and glazing materials according to manufacturer's written instructions. Prevent damage from condensation, temperature changes, direct exposure to sun, or other causes.

## 13.2 FIELD CONDITIONS

PART 13 MAINTAIN ENVIRONMENTAL CONDITIONS (TEMPERATURE, HUMIDITY, AND VENTILATION) WITHIN LIMITS RECOMMENDED BY MANUFACTURER FOR OPTIMUM RESULTS. DO NOT INSTALL PRODUCTS UNDER ENVIRONMENTAL CONDITIONS OUTSIDE MANUFACTURER'S RECOMMENDED LIMITS.

14.1 Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

#### 14.2 WARRANTY

- A. Manufacturer's Special Standard Warranty on Security Glass: Provide manufacturer's standard limited warranty for defects in materials and workmanship. Manufacturer agrees to replace security glass that deteriorates within specified warranty period. Deterioration of security glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning security glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced standard.
- B. Verify available warranties and warranty periods with manufacturers listed in Part 2 articles. Revise "Warranty Period" Subparagraph below if glazing manufacturers insist on warranty beginning on date of manufacture. See the Evaluations.
  1. Warranty Period: 10 years from date of Substantial Completion.

### PART 14 PRODUCTS

#### 15.1 MANUFACTURERS

- A. Source Limitations for Security Glazing Bullet-Resistant Panels: : Panels manufactured in the United States of America with raw materials sourced from the U.S.A. for quality assurance purposes and to comply with any applicable "Buy American" provisions.

#### 15.2 BULLET-RESISTANT PANELS, GENERAL

- A. Basis of Design Product: Subject to compliance with requirements, provide ArmorCore Level 4 Bullet Resistant Panels manufactured by Waco Composites, or a comparable product by one of the following:
- B. Armortex, Inc.
  1. CR Laurence Company
  2. Saftifirst
  3. Total Security Solutions

PART 15 BULLET RESISTANT PANELS SHALL BE "NON-RICOCHET TYPE" TO PERMIT THE ENCAPTURE AND RETENTION OF AN ATTACKING PROJECTILE LESSENING THE POTENTIAL OF A RANDOM INJURY OR LATERAL PENETRATION.

- 16.1 Product: Panels shall be fabricated of multiple layers of ballistic grade materials impregnated with a thermoset plastic and compressed into flat rigid sheets.
- A. Panel Requirements:
1. Ballistic Rating: UL752 Level 4.
  2. Armor Type: NIJ Standard 0108.01
  3. Physical Characteristics: 1 3/8 inches thick, 13.9 lbs per sq. ft.
  4. Panel Size: 48 inches by 96 inches, cut to size as required.
  5. Fire Resistance: 60-minute rating per ASTM E119-98
  6. Obtain security glazing from single source from single manufacturer using the same types of lites, plies, films, interlayers, and spacers for each security glazing type indicated.
  7. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.
- 16.2 PERFORMANCE REQUIREMENTS
- A. General:
1. Installed security glazing shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing; or other defects in construction.
  2. Installed security glazing shall withstand security-related loads and forces without damage to the glazing beyond that allowed by referenced standards.
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design security glazing.
- C. Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the 2015 IBC and ASTM E 1300.
1. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glazing framing members and glazing components.
1. Temperature Change: 120 deg F ambient; 180 deg F material surfaces.

- E. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.

### 16.3 SECURITY GLAZING, GENERAL

- A. Glazing Publications: Comply with published recommendations of security glazing and glazing material manufacturers and organizations below unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
  - 1. GANA Publications: "Glazing Manual."
  - 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Plastic Glazing Labeling: Identify plastic sheets with appropriate markings of applicable testing and inspecting agency, indicating compliance with required fire-test-response characteristics.
- C. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction or manufacturer. Label shall indicate manufacturer's name, type of glazing, glass thickness, and safety glazing standard with which glazing complies.
- D. Insulating Glazing Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of the Insulating Glass Certification Council.
- E. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
- F. Fire-Test-Response Characteristics of Polycarbonate Sheets: As determined by testing polycarbonate sheets identical to those used in security glazing products by a qualified testing agency acceptable to authorities having jurisdiction.
  - 1. Self-ignition temperature of 650 deg F or more when tested according to ASTM D1929 on plastic sheets in thicknesses indicated for the Work.
  - 2. Smoke-Developed Index of 450 or less when tested according to ASTM E84, or smoke density of 75 or less when tested according to ASTM D2843 on plastic sheets in thicknesses indicated for the Work.
  - 3. Burning extent of 1 inch or less when tested according to ASTM D635 at a nominal thickness of 0.060 inch or thickness indicated for the Work.
- G. Thermal and Optical Performance Properties: Provide security glazing with performance properties specified, as indicated in manufacturer's published test data, based on construction products indicated and on procedures indicated below:

1. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F.
2. Solar-Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
3. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

#### 16.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
- B. Float Glass: ASTM C1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
- C. Heat-Treated Float Glass: ASTM C1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.

#### 16.5 NON-RATED SECURITY (BALLISTIC) GLAZING

- A. Glazing Type BA or "Non-Rated Ballistic Glass"
  1. Basis of Design Product: Subject to compliance with requirements, provide 3/8 inch Security Glass manufactured by Armoured One, or a comparable product by one of the following:
    - a. DefenseLite.
    - b. Gaffco Ballistics.
    - c. Patriot Armor.
- B. Glazing Components:
  1. 3/8 inch overall thickness.
    - a. Threat Side Coating: Specified Security Film.
    - b. Threat Side Glazing: 1/4 inch Clear Annealed Glass.
    - c. Interlayer: Manufacturer's Standard Security Interlayer.
    - d. Secure Side Glazing: 1/4 inch Clear Annealed Glass.

#### 16.6 FIRE RATED SECURITY (BALLISTIC) GLAZING

- A. Glazing Type "45 Min. Fire Rated Ballistic Glass"
  1. Basis of Design Product: Subject to compliance with requirements, provide 5/8 inch 45 Minute Fire Rated Shooter Attack Glass manufactured by Armoured One, or a comparable product by one of the following:
    - a. DefenseLite.
    - b. Gaffco Ballistics.
    - c. Patriot Armor.
    - d. Safti First.
- B. Glazing Components:
  1. 5/8 inch overall thickness.

- a. Threat Side Coating: Specified Security Film.
    - b. Threat Side Glazing: 1/4 inch Clear Annealed Glass.
    - c. Interlayer: Manufacturer's Standard Fire Rated Security Interlayer.
    - d. Secure Side Glazing: 1/4 inch Clear Annealed Glass.
  - 1) SECURITY FILM MATERIALS
  - C. Security Glazing Film: Installed on glazing assemblies to provide impact resistance and forced/attack resistance complying with WEY-SA-C1, ANSI Z97.1 and CPSC 16 CFR 1201 Category II, ASTM E330, UL972, EN356 P4A, and GSA Level C as specified:
    - 1. Basis of Design Product: Subject to compliance with requirements, provide 23 Mil Security Film manufactured by Armoured One, or a comparable product by one of the following:
      - a. 3M United States
      - b. CJ Buffer
      - c. Gaffco Ballistics
      - d. Total Security Solutions
  - D. Film Materials: Surface applied Transparent polyester film for permanent bonding to glass.
    - 1. Thickness: 0.021 inch, minimum. Must be a single layer film. Multi-layering film to achieve thickness is not acceptable.
    - 2. Color: Clear.
    - 3. Construction: 3-ply laminate.
    - 4. Adhesive Type: Pressure sensitive.
    - 5. Tensile Strength: 28,5000 psi minimum.
    - 6. Breaking Strength: 615 lbs/inch.
    - 7. Elongation at Break: 230 %
    - 8. Surface Burning Characteristics: Flame spread index of 25, maximum, and smoke developed index of 450, maximum, when tested in accordance with ASTM E84 (Class A).
  - E. Anchoring System: Provide supplemental anchoring system as required to meet forced entry resistance requirements.
    - 1. DOW 995 or GE SCS2000 SilPruf Structural Sealant with high impact styrene trim.
  - F. Warranty: Provide 12 year manufacturer's replacement warranty to cover film against peeling, cracking, discoloration and deterioration.
- 16.7 GLAZING SEALANTS
- A. General:



1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they contact, including security glazing, seals of insulating security glazing and air-gap security glazing, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
  2. Suitability: Comply with sealant and security glazing manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
  3. Field-applied sealants shall have a VOC content of not more than 250 g/L.
  4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C920, Type S, Grade NS, Class 100/50, Use NT.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Dow Corning Corporation; 790.
    - b. GE Construction Sealants; Momentive Performance Materials Inc.; SCS2700 SilPruf LM.
    - c. May National Associates, Inc.; a subsidiary of Sika Corporation; Bondaflex Sil 290.
    - d. Pecora Corporation; 890NST.
    - e. Sika Corporation; SikaSil WS-290.
    - f. Tremco Incorporated; Spectrem 1.
- C. Security Sealant: Manufacturer's standard, non-sag, tamper-resistant sealant for joints with low movement complying with ASTM C920, Grade NS, Class 12.5 or 25, Use NT, and with a Shore A hardness of at least 45 when tested according to ASTM C661.

#### 16.8 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; non-staining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and security glazing manufacturers for application indicated; and complying with ASTM C1281 and AAMA 800 for products indicated below:
1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
  2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.

2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

#### 16.9 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of security glazing and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by security glazing manufacturer to maintain security glazing lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit security glazing lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

#### 16.10 FABRICATION OF SECURITY GLAZING

- A. Fabricate security glazing in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
- B. Grind smooth and polish exposed security glazing edges and corners.

### PART 16 EXECUTION

#### 17.1 EXAMINATION

PART 17 DO NOT BEGIN INSTALLATION UNTIL SUBSTRATES HAVE BEEN PROPERLY PREPARED.

PART 18 PRIOR TO STARTING INSTALLATION, VERIFY WORK OF RELATED TRADES REQUIRED IN CONTRACT DOCUMENTS AND ARCHITECTURAL DRAWINGS IS COMPLETE TO THE POINT WHERE WORK OF THIS SECTION MAY PROPERLY COMMENCE.

PART 19 IF SUBSTRATE PREPARATION IS THE RESPONSIBILITY OF ANOTHER INSTALLER, NOTIFY ARCHITECT OF UNSATISFACTORY PREPARATION BEFORE PROCEEDING.

- 20.1 Examine framing for security glazing, with Installer present, for compliance with the following:
1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
  2. Presence and functioning of weep system.
  3. Minimum required face or edge clearances.
  4. Minimum required bite.
  5. Effective sealing between joints of framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

## 20.2 PREPARATION

PART 20 CLEAN SURFACES THOROUGHLY PRIOR TO INSTALLATION.

PART 21 PREPARE SURFACES USING THE METHODS RECOMMENDED BY THE MANUFACTURER FOR ACHIEVING THE BEST RESULT FOR THE SUBSTRATE UNDER THE PROJECT CONDITIONS.

- 22.1 Clean glazing channels and other framing members receiving security glazing immediately before glazing. Remove coatings not firmly bonded to substrates.
- A. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.
- 22.2 GLAZING, GENERAL
- A. Comply with combined written instructions of manufacturers of security glazing, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect edges of security glazing from damage during handling and installation. Remove damaged security glazing from Project site and legally dispose of off Project site. Damaged security glazing includes units with edge or face damage or other imperfections that, when installed, could weaken security glazing and impair performance and appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications unless otherwise required by glazing unit manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by security glazing manufacturers for installing lites.
- F. Provide spacers for security glazing lites where the length plus width is larger than 50 inches (1270 mm).
  - 1. Locate spacers directly opposite each other on both inside and outside faces of security glazing. Install correct size and spacing to preserve required face clearances unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with performance requirements.
  - 2. Provide 1/8-inch (3-mm) minimum bite of spacers on glazing lites and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. Provide edge blocking where indicated or needed to prevent security glazing from moving sideways in glazing channel, as recommended in writing by security glazing manufacturer and according to requirements in referenced glazing publications.
- H. Set security glazing in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set coated security glazing with proper orientation so that coatings and films face exterior or interior as specified.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

## 22.3 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by security glazing, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.

- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until just before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. Center security glazing in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

#### 22.4 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket securely in place between glazing unit and frame or fixed stop, so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center security glazing in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in security glazing. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center security glazing in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in security glazing. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

#### 22.5 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between security glazing and glazing stops to maintain face clearances and to prevent sealant from extruding into glazing channel and blocking weep systems. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to security glazing and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial washaway from security glazing.

## 22.6 INSTALLATION

PART 22 INSTALL IN ACCORDANCE WITH MANUFACTURER'S INSTRUCTIONS AND IN PROPER RELATIONSHIP WITH ADJACENT CONSTRUCTION.

PART 23 REINFORCE JOINTS WITH A BACK-UP LAYER OF BULLET RESISTIVE MATERIAL. MINIMUM WIDTH OF REINFORCING LAYER AT JOINT SHALL BE 4 INCHES, CENTERED ON PANEL JOINTS.

PART 24 INSTALL PANELS IN ACCORDANCE WITH MANUFACTURER'S PRINTED RECOMMENDATIONS AND AS REQUIRED BY CONTRACT DOCUMENTS.

- 25.1 Bullet Resistant panels can be installed using an industrial adhesive, mastic, screws or bolts. Method of application shall maintain the bullet resistive rating at junctures with the concrete floor slab, concrete roof slab, bullet resistive door frames, bullet resistive window frames, and all required penetrations.
- 25.2 All joints reinforced by a back-up layer of bullet resistive material.
- 25.3 Bullet resistance of the joint, as reinforced, shall be at least equal to that of the panel.
- 25.4 Minimum width of reinforcing layer at joint shall be 4 inches (2 inches on each panel or a 2 inch minimum overlap).
  - A. Method of application shall install panels minimizing vulnerabilities by fitting tightly to adjacent surfaces including concrete floor slab, concrete roof slab, bullet resistive door frames, bullet resistive window frames, and other assemblies.

INSTALLATION TOLERANCES: DO NOT EXCEED THE FOLLOWING INSTALLATION TOLERANCES:

- 26.1 Squareness: Plus or minus 1/16 inch measured on a line, 90 degrees from one jamb, at the upper corner of the frame at the other jamb.
- 26.2 Alignment: Plus or minus 1/16 inch measured on jambs on a horizontal line parallel to the plane of the wall.
- 26.3 Twist: Plus or minus 1/16 inch measured at face corners of jambs on parallel lines perpendicular to the plane of the wall.
- 26.4 Plumb: Plus or minus 1/16 inch measured on the jamb at the floor.
- 26.5 CLEANING AND PROTECTION

PART 25 PROTECT INSTALLED PRODUCTS UNTIL COMPLETION OF PROJECT.

PART 26 TOUCH-UP, REPAIR OR REPLACE DAMAGED PRODUCTS BEFORE SUBSTANTIAL COMPLETION.

- 28.1 Immediately after installation remove nonpermanent labels and clean surfaces.
  - A. Protect security glazing from contact with contaminating substances resulting from construction operations, including weld splatter. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
    - 1. If, despite such protection, contaminating substances do come into contact with security glazing, remove substances immediately as recommended in writing by security glazing manufacturer. Remove and replace security glazing that cannot be cleaned without damage.
  - B. Wash security glazing on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash security glazing as recommended in writing by security glazing manufacturer.

END OF SECTION

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## SECTION 102800 - TOILET AND CUSTODIAL ACCESSORIES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Toilet Room accessories.
  - 2. Custodial accessories.
- B. Related Requirements:

#### 1.2 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning, and servicing of accessories.
- B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the Work.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
- B. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required.
  - 1. Identify locations using room designations indicated.
  - 2. Identify accessories using designations indicated.
- C. Delegated Design Submittal: For grab bars.
  - 1. Include structural design calculations indicating compliance with specified structural-performance requirements.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Sample Warranty: For manufacturer's special warranties.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For accessories to include in maintenance manuals.

## 1.6 WARRANTY

- A. Manufacturer's Special Warranty for Mirrors: Manufacturer agrees to repair or replace mirrors that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, visible silver spoilage defects.
  - 2. Warranty Period: Ten years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Design accessories and fasteners to comply with the following requirements:
  - 1. Grab Bars: Installed units are able to resist 250 lbf concentrated load applied in any direction and at any point.

### 2.2 TOILET ROOM ACCESSORIES

- A. Source Limitations: Owner and Contractor shall obtain each type of Toilet Room accessory from single source from single manufacturer as indicated below:
- B. Toilet Tissue (Roll) Dispensers – All Toilet Rooms
  - 1. Owner Furnished and Contractor Installed.
  - 2. Basis of Design Product: Subject to compliance with requirements, Owner shall furnish, and Contractor shall install Toilet Tissue (Roll) Dispensers. Owner shall furnish accessories from the following manufacturers:
    - a. AJW Architectural Products
    - b. American Specialties, Inc.
    - c. Bobrick Washroom Equipment, Inc.
    - d. Bradley Corp.
    - e. Gamco USA
    - f. Georgia-Pacific Consumer Products LP
    - g. Inpro Architectural Products
    - h. Or Approved Equal
  - 3. Description: Roll dispenser.
  - 4. Mounting: Surface mounted.
- C. Automatic Paper Towel (Roll) Dispensers – All Faculty and Public Use Toilet Rooms
  - 1. Owner Furnished and Contractor Installed.

2. Basis of Design Product: Subject to compliance with requirements, Owner shall furnish, and Contractor shall install Automatic Paper Towel (Roll) Dispensers. Owner shall furnish accessories from the following manufacturers:
    - a. AJW Architectural Products
    - b. American Specialties, Inc.
    - c. Bobrick Washroom Equipment, Inc.
    - d. Bradley Corp.
    - e. Gamco USA
    - f. Georgia-Pacific Consumer Products LP
    - g. Inpro Architectural Products
    - h. Or Approved Equal
  3. Description: Automatic motion sensing mechanism with user-adjustable delay and paper towel length; battery powered.
  4. Mounting: Surface mounted.
- D. Paper Towel (Roll) Dispensers – All Classroom Toilet Rooms
1. Owner Furnished and Contractor Installed.
  2. Basis of Design Product: Subject to compliance with requirements, Owner shall furnish, and Contractor shall install Paper Towel (Roll) Dispensers. Owner shall furnish accessories from the following manufacturers:
    - a. AJW Architectural Products
    - b. American Specialties, Inc.
    - c. Bobrick Washroom Equipment, Inc.
    - d. Bradley Corp.
    - e. Gamco USA
    - f. Georgia-Pacific Consumer Products LP
    - g. Inpro Architectural Products
    - h. Or Approved Equal
  3. Description: Lever-actuated mechanism permitting controlled delivery of paper rolls in preset lengths.
  4. Mounting: Surface mounted.
- E. Automatic Soap Dispensers – All Faculty and Public Use Toilet Rooms
1. Owner Furnished and Contractor Installed.
  2. Basis of Design Product: Subject to compliance with requirements, Owner shall furnish, and Contractor shall install Automatic Soap Dispensers. Owner shall furnish accessories from the following manufacturers:
    - a. AJW Architectural Products
    - b. American Specialties, Inc.
    - c. Bobrick Washroom Equipment, Inc.
    - d. Bradley Corp.
    - e. Gamco USA
    - f. Georgia-Pacific Consumer Products LP

- g. Inpro Architectural Products
    - h. Or Approved Equal
  - 3. Description: Automatic dispenser with infrared sensor to detect presence of hands; battery powered; designed for dispensing soap in liquid or lotion form.
  - 4. Mounting: Surface mounted.
- F. Soap Dispensers – All Classroom Toilet Rooms
  - 1. Owner Furnished and Contractor Installed.
  - 2. Basis of Design Product: Subject to compliance with requirements, Owner shall furnish, and Contractor shall install Soap Dispensers. Owner shall furnish accessories from the following manufacturers:
    - a. AJW Architectural Products
    - b. American Specialties, Inc.
    - c. Bobrick Washroom Equipment, Inc.
    - d. Bradley Corp.
    - e. Gamco USA
    - f. Georgia-Pacific Consumer Products LP
    - g. Inpro Architectural Products
    - h. Or Approved Equal
  - 3. Description: Designed for manual operation and dispensing soap in liquid or lotion form.
  - 4. Mounting: Vertically oriented, surface mounted.
- G. Sanitary-Napkin Disposal Units – All Faculty and Public Use Toilet Rooms
  - 1. Owner Furnished and Contractor Installed
  - 2. Basis of Design Product: Subject to compliance with requirements, Owner shall furnish, and Contractor shall install Sanitary-Napkin Disposal Units. Owner shall furnish accessories from the following manufacturers:
    - a. AJW Architectural Products
    - b. American Specialties, Inc.
    - c. Bobrick Washroom Equipment, Inc.
    - d. Bradley Corp.
    - e. Gamco USA
    - f. Georgia-Pacific Consumer Products LP
    - g. Inpro Architectural Products
    - h. Or Approved Equal
  - 3. Mounting: Surface mounted.
  - 4. Door or Cover: Self-closing, disposal-opening cover and hinged face panel with tumbler lockset.
- H. Grab Bars – All Toilet Rooms
  - 1. Contractor Furnished and Installed

2. Basis of Design Product: Subject to compliance with requirements, Contractor shall provide 1 1/2" Diameter Snap Flange Grab Bars, 3800 Series manufactured by American Specialties, Inc. or a comparable product by one of the following:
    - a. AJW Architectural Products
    - b. Bobrick Washroom Equipment, Inc.
    - c. Bradley Corp.
    - d. Gamco USA
    - e. Georgia-Pacific Consumer Products LP
    - f. Inpro Architectural Products
    - g. Or Approved Equal
  3. Mounting: Flanges with concealed fasteners.
  4. Tubing Material: 18-gauge, stainless steel, type 304.
  5. Cover/Flange Material: 22-gauge, stainless steel, type 304.
    - a. Finish: Smooth on ends and slip-resistant texture in grip area.
  6. Outside Diameter: 1-1/2 inches.
  7. Configuration and Length: As indicated on Drawings.
- I. Mirror Units – All Toilet Rooms
1. Contractor Furnished and Installed
  2. Basis of Design Product: Subject to compliance with requirements, Contractor shall provide Fixed Tilt Mirror, 0535 Series manufactured by American Specialties, Inc. or a comparable product by one of the following:
    - a. AJW Architectural Products
    - b. Bobrick Washroom Equipment, Inc.
    - c. Bradley Corp.
    - d. Gamco USA
    - e. Georgia-Pacific Consumer Products LP
    - f. Inpro Architectural Products
    - g. Or Approved Equal
  3. Frame: 20-gauge, stainless steel angle, adjustable tilt.
  4. Corners: Manufacturer's standard.
  5. Size: As indicated on Drawings.
- J. Robe Hooks – All Toilet Rooms
1. Contractor Furnished and Installed
  2. Basis of Design Product: Subject to compliance with requirements, Contractor shall provide Double, Surface-Mounted Robe Hook, Model 0745-Z manufactured by American Specialties, Inc. or a comparable product by one of the following:
    - a. AJW Architectural Products
    - b. Bobrick Washroom Equipment, Inc.
    - c. Bradley Corp.
    - d. Gamco USA
    - e. Georgia-Pacific Consumer Products LP

- f. Inpro Architectural Products
- g. Or Approved Equal
- 3. Description: Double-prong unit.
- 4. Material and Finish: Stainless steel.

## 2.3 CUSTODIAL ACCESSORIES

- A. Source Limitations: Owner and Contractor shall obtain each type of custodial accessories from single source from single manufacturer as indicated below:
- B. Paper Towel (Roll) Dispensers – All Custodial Areas
  - 1. Owner Furnished and Contractor Installed.
  - 2. Basis of Design Product: Subject to compliance with requirements, Owner shall furnish, and Contractor shall install Paper Towel (Roll) Dispensers. Owner shall furnish accessories from the following manufacturers:
    - a. AJW Architectural Products
    - b. American Specialties, Inc.
    - c. Bobrick Washroom Equipment, Inc.
    - d. Bradley Corp.
    - e. Gamco USA
    - f. Georgia-Pacific Consumer Products LP
    - g. Inpro Architectural Products
    - h. Or Approved Equal
  - 3. Description: Lever-actuated mechanism permitting controlled delivery of paper rolls in preset lengths.
  - 4. Mounting: Surface mounted.
- C. Soap Dispensers – All Custodial Areas
  - 1. Owner Furnished and Contractor Installed.
  - 2. Basis of Design Product: Subject to compliance with requirements, Owner shall furnish, and Contractor shall install Soap Dispensers. Owner shall furnish accessories from the following manufacturers:
    - a. AJW Architectural Products
    - b. American Specialties, Inc.
    - c. Bobrick Washroom Equipment, Inc.
    - d. Bradley Corp.
    - e. Gamco USA
    - f. Georgia-Pacific Consumer Products LP
    - g. Inpro Architectural Products
    - h. Or Approved Equal
  - 3. Description: Designed for manual operation and dispensing soap in liquid or lotion form.
  - 4. Mounting: Vertically oriented, surface mounted.

D. Custodial Mop and Broom Holders – All Custodial Areas

1. Contractor Furnished and Installed
2. Basis of Design Product: Subject to compliance with requirements, provide 34" Long Utility Shelf and Mop Strip with 4 Hooks 3 Holders, Model 8215-4 manufactured by American Specialties, Inc. or a comparable product by one of the following:
  - a. AJW Architectural Products
  - b. Bobrick Washroom Equipment, Inc.
  - c. Bradley Corp.
  - d. Gamco USA
  - e. Georgia-Pacific Consumer Products LP
  - f. Inpro Architectural Products
  - g. Or Approved Equal
3. Description: Unit with shelf, hooks, and holders.
4. Length: 34 inches.
5. Hooks: Four
6. Mop/Broom Holders: Three spring-loaded, rubber hat, cam type.

2.4 Material and Finish: Stainless steel, type 304.MATERIALS

- A. Stainless Steel: ASTM A240/A240M or ASTM A666, Type 304, 0.031-inch minimum nominal thickness unless otherwise indicated.
- B. Brass: ASTM B19, flat products; ASTM B16/B16M, rods, shapes, forgings, and flat products with finished edges; or ASTM B30, castings.
- C. Steel Sheet: ASTM A1008/A1008M, Designation CS (cold rolled, commercial steel), 0.036-inch minimum nominal thickness.
- D. Galvanized-Steel Sheet: ASTM A653/A653M, with G60 hot-dip zinc coating.
- E. Galvanized-Steel Mounting Devices: ASTM A153/A153M, hot-dip galvanized after fabrication.
- F. Fasteners: Screws, bolts, and other devices of same material as accessory unit, unless otherwise recommended by manufacturer or specified in this Section, and tamper and theft resistant where exposed, and of stainless or galvanized steel where concealed.
- G. Mirrors: ASTM C1503, Mirror Glazing Quality, clear-glass mirrors, nominal 6.0 mm thick.

2.5 FABRICATION

- A. General: Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full-length, continuous hinges. Equip units for concealed anchorage and with corrosion-resistant backing plates.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install accessories in accordance with manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.
  - 1. Remove temporary labels and protective coatings.
- B. Grab Bars: Install to comply with specified structural-performance requirements.

### 3.2 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.
- B. Clean and polish exposed surfaces in accordance with manufacturer's written instructions.

END OF SECTION



## SECTION 104416 - FIRE EXTINGUISHERS AND CABINETS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Include:
  - 1. Portable, hand-carried fire extinguishers.
  - 2. Fire-protection cabinets.
  - 3. Mounting brackets for fire extinguishers.

#### 1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:
    - a. Schedules and coordination requirements.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguishers and mounting brackets.
  - 2. Show door hardware, cabinet type, trim style, and panel style. Include roughing-in dimensions and details showing recessed, semi-recessed, or surface-mounting method and relationships of box and trim to surrounding construction.
- B. Shop Drawings: For fire-protection cabinets.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples: For each type of exposed finish required.
- D. Samples for Initial Selection: For each type of exposed finish required.
- E. Samples for Verification: For each type of exposed finish required, prepared on samples 6 by 6 inches square.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire extinguishers and fire-protection cabinets to include in maintenance manuals.

## 1.6 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.
- B. Coordinate sizes and locations of fire-protection cabinets with wall depths.

## 1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Failure of hydrostatic test according to NFPA 10 when testing interval required by NFPA 10 is within the warranty period.
    - b. Faulty operation of valves or release levers.
  - 2. Warranty Period: Six years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Source Limitations: Obtain fire-protection cabinets, accessories, and fire extinguishers from single source from single manufacturer

### 2.2 PERFORMANCE REQUIREMENTS

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
  - 1. Provide fire extinguishers approved, listed, and labeled by FM Global.
- C. Fire-Rated Fire-Protection Cabinets: Listed and labeled to comply with requirements in ASTM E814 for fire-resistance rating of walls where they are installed.

### 2.3 MANUFACTURERS:

- A. Source Limitations: Obtain fire extinguishers, fire-protection cabinets, and accessories, from single source from single manufacturer.

## 2.4 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

- A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
  - 1. Basis of Design Product: Subject to compliance with requirements, provide 3000 Series ABC Multi-Purpose Dry Chemical Portable Fire Extinguishers manufactured by Potter Roemer, LLC or a comparable product by one of the following:
    - a. Activar Construction Products Group, Inc.
    - b. Babcock-Davis
    - c. Johnson Controls
  - 2. Valves: Manufacturer's standard
  - 3. Handles and Levers: Manufacturer's standard
  - 4. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B, and bar coding for documenting fire-extinguisher location, inspections, maintenance, and recharging.
- B. Multipurpose Dry-Chemical Type in Steel Container : UL-rated 4-A:80-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

## 2.5 FIRE-PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
  - 1. Basis of Design Product: Subject to compliance with requirements, provide 7000 Series Alta Fire Extinguisher Cabinets manufactured by Potter Roemer, LLC or a comparable product by one of the following:
    - a. Activar Construction Products Group, Inc.
    - b. Babcock-Davis
    - c. Johnson Controls
- B. Cabinet Material: Cold-rolled steel sheet.
  - 1. Shelf: Same metal and finish as cabinet.
- C. Semi-recessed Cabinet: One-piece combination trim and perimeter door frame overlapping surrounding wall surface, with exposed trim face and wall return at outer edge (backbend).
  - 1. Square-Edge Trim: 1-1/4- to 1-1/2-inch backbend depth.
- D. Cabinet Trim Material: Steel sheet.
- E. Door Material: Steel sheet.
- F. Door Style: Fully glazed panel with frame.
- G. Door Glazing: Tempered break glass.

- H. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
  - 1. Provide projecting lever handle with cam-action latch.
  - 2. Provide manufacturer's standard hinge, permitting door to open 180 degrees.
- I. Accessories:
  - 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
  - 2. Break-Glass Strike: Manufacturer's standard metal strike, complete with chain and mounting clip, secured to cabinet.
  - 3. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Architect.
    - a. Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER"
      - 1) Location: Applied to cabinet glazing.
      - 2) Application Process: Decals.
      - 3) Lettering Color: Red.
      - 4) Orientation: Vertical.
- J. Materials:
  - 1. Cold-Rolled Steel: ASTM A1008/A1008M, Commercial Steel (CS), Type B.
    - a. Finish: Baked enamel, TGIC polyester powder coat, HAA polyester powder coat, epoxy powder coat, or polyester/epoxy hybrid powder coat, complying with AAMA 2603.
    - b. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - c. Color: As selected by Architect from manufacturer's full range.
  - 2. Tempered Break Glass: ASTM C1048, Kind FT, Condition A, Type I, Quality q3, 1.5 mm thick.

## 2.6 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
  - 1. Orientation: Vertical.

## 2.7 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
  - 1. Weld joints and grind smooth.
  - 2. Miter corners and grind smooth.
  - 3. Provide factory-drilled mounting holes.
  - 4. Prepare doors and frames to receive locks.
  - 5. Install door locks at factory.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles.
  - 1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
  - 2. Fabricate door frames of one-piece construction with edges flanged.
  - 3. Miter and weld perimeter door frames and grind smooth.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

## 2.8 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's AMP 500, "Metal Finishes Manual for Architectural and Metal Products," for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces of fire-protection cabinets from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.
- D. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine fire extinguishers for proper charging and tagging.
  - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Examine walls and partitions for suitable framing depth and blocking where recessed and semi-recessed cabinets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Prepare recesses for recessed and semi-recessed fire-protection cabinets as required by type and size of cabinet and trim style.

### 3.3 INSTALLATION

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
- B. General: Install fire-protection cabinets in locations and at mounting heights indicated.
  - 1. Fire-Protection Cabinet Mounting Height: 42 inches above finished floor to top of fire extinguisher.
- C. Fire-Protection Cabinets: Fasten cabinets to structure, square and plumb.
  - 1. Unless otherwise indicated, provide semi-recessed fire-protection cabinets.
  - 2. Provide inside latch and lock for break-glass panels.
  - 3. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
- D. Identification:
  - 1. Apply decals at locations indicated and on field-painted fire-protection cabinets after painting is complete.

### 3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire-protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet and mounting bracket manufacturers.
- E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

## SECTION 116833 - TENNIS COURT EQUIPMENT

### PART 1 – GENERAL

#### 1.1 SECTION INCLUDES

- A. Installation of windscreen and net posts, as indicated on the Contract Documents including the layout and line striping of lines and markings.

#### 1.2 RELATED SECTIONS

- A. Section 31 20 00 – Excavation and Fill
- B. Section 32 12 16 – Asphalt Paving

#### 1.3 SUBMITTALS

- A. Comply with the requirements of Section 01 33 00 – Submittal Procedures and as modified below.
- B. Product Data: Submit manufacturer's name, specifications and installation instructions for each item specified.
- C. Shop drawings indicating layout and placement of net systems.
- D. Closeout Procedures: Comply with the requirements of Section 01 77 00.

#### 1.4 REFERENCES

- A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirements shall govern.
  - 1. National Federation of State High School Associations (NFHS)
  - 2. National Collegiate Athletic Association (NCAA)
  - 3. International Association of Athletics Federations (IAAF)
  - 4. American Sports Builders Association (ASBA)
  - 5. Manufacturers Data and Recommended Installation Requirements

#### 1.5 MATERIAL HANDLING AND STORAGE

- A. Store materials in accordance with manufactures specifications and MSDS.
- B. All surfacing material shall be non-flammable.

- C. NO MATERIAL STORED ON SITE during the duration of the project unless fully secured with fencing.

#### 1.6 GUARENTEE

- A. Provide guarantee against defects in the materials and workmanship for a period of one (1) year from the date of substantial completion unless otherwise stated.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURER

- A. Douglas Industries, Eldridge IA./ Athletic Equipment.
- B. Sportsfield Specialties, Inc.
- C. Approved equivalents accepted.

#### 2.2 MATERIALS

- A. Net Post -
  - 1. Height: 3'-6" (42") Above Finish Grade
  - 2. 2-7/8" O.D. 12 Gauge Steel
  - 3. Black Powder Coated Finish
  - 4. External Winding Mechanism with Removable Aluminum Hand Crank
- B. Ground Sleeves - Installed in concrete footings 2 per court.
  - 1. 3" I.D. x 2'L (24"L) PVC
- C. Center anchor- Installed in concrete. One (1) per court.
  - 1. 10"L x 10 Gauge Steel Pipe
- D. Tennis Net Posts -Installed in ground sleeve 2 per court. Owner to select color.
- E. Tennis Net - Connect to tennis net posts.
  - 1. 41'-7" X 3'-6"
  - 2. Netting Body: 3.5mm Braided Polyethylene Rope, 1-1/2" Knotted Mesh, Double Braiding on the Top Seven (7) Rows
  - 3. Headband: 51 oz. Double-Layered White Vinyl, Folded and Tucked, Treated with UV and Mildew Inhibitors, 2-1/2" Wide, Six (6) Rows of Bonded Thread Interlocking Stitching, Built-in Grommets
  - 4. Sideband: 2-1/2" Black Vinyl, Built-in Grommets, Sewn Pocket, Two (2) Hollow Fiberglass Rods
  - 5. Bottom Band: 2-1/2" Black Vinyl, Built-in Grommets
  - 6. Cable: 5mm Steel Coated Cable, 3600 lb. Tensile Strength, 46' Long



- F. Center strap - Fastened to center anchor. Heavy-Duty Polyester Webbing, Nickel Plated Slide Buckles, Double End Hook, Reinforced Ends
- G. Windscreen – Fastened to chain link fence.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- 3.2 Installer Verification of Conditions: Examine conditions under which running track surfacing is to be constructed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Project Designer shall be notified in writing of any conditions detrimental to the proper and timely installation of the work. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Project Designer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

#### 3.3 PREPARATION

- A. Tennis post foundations shall be situated to provide a clear distance between posts four-foot-two inches (42") apart.
- B. Net post sleeves shall be installed with foundations of no less than twenty-four inches (24") in diameter at the top, no less than thirty inches (30") in diameter at the base, and no less than forty-eight inches (48") in depth.
- C. Center strap anchor foundations shall be no less than twelve inches (12") in diameter at the top, no less than sixteen inches (16") at the base, and no less than twelve inches (12") in depth.
- D. Install tennis posts in sleeves, follow manufacturers installation guidelines.
- E. Install tennis nets, follow manufacturer's installation guidelines.
- F. Install center straps, follow manufacturer's installation guidelines.
- G. Install 120-foot long by 6-foot-high HDPE windscreen on west length of chain link fence, per manufacturer's installation guidelines. District to confirm color.

END OF SECTION

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## SECTION 122413 - ROLLER WINDOW SHADES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Manually operated, single-roller shades.
- B. Related Requirements:
  - 1. Section 061000 "Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
  - 2. Section 079200 "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
- B. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
- C. Samples: For each exposed product and for each color and texture specified, 10 inches long.
- D. Samples for Initial Selection: For each type and color of shadeband material.
  - 1. Include Samples of accessories involving color selection.
- E. Samples for Verification: For each type of roller shade.
  - 1. Shadeband Material: Not less than 3 inches square. Mark interior face of material if applicable.
  - 2. Roller Shade: Full-size operating unit, not less than 16 inches wide by 36 inches long for each type of roller shade indicated.
  - 3. Installation Accessories: Full-size unit, not less than 10 inches long.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of shadeband material.

- C. Product Test Reports: For each type of shadeband material, for tests performed by a qualified testing agency.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roller shades to include in 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. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and shadeband material indicated, but no fewer than two units.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

#### 1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

### PART 2 PRODUCTS

#### 2.1 SOURCE LIMITATIONS

- A. Obtain roller shades from single source from single manufacturer.

#### 2.2 MANUALLY OPERATED, SINGLE-ROLLER SHADES

- A. Basis of Design Product: Subject to compliance with requirements, provide Techmatic Roller Shades manufactured by Draper Canopies or a comparable product by one of the following:
  - 1. Levolor Commercial
  - 2. MechoShade Systems, LLC
  - 3. Rollease Acmeda
- B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
  - 1. Bead Chains: Manufacturer's standard.
    - a. Loop Length: Full length of roller shade.
    - b. Limit Stops: Provide upper and lower ball stops.
    - c. Chain-Retainer Type: Chain tensioner, jamb mounted.
- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- E. Shadebands:
  - 1. Shadeband Material: Light-filtering fabric.
  - 2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
    - a. Type: Enclosed in sealed pocket of shadeband material.
    - b. Color and Finish: As selected by Architect from manufacturer's full range.
- F. Installation Accessories:
  - 1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
    - a. Shape: L-shaped
    - b. Height: Manufacturer's standard height required to conceal roller and shadeband assembly when shade is fully open, but not less than 3 inches.
  - 2. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
    - a. Height: Manufacturer's standard height required to enclose roller and shadeband assembly when shade is fully open, but not less than 3 inches.
  - 3. Endcap Covers: To cover exposed endcaps.
  - 4. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.

5. Installation Accessories Color and Finish: As selected from manufacturer's full range.

## 2.3 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
  1. Source: Roller shade manufacturer.
  2. Type: Woven polyester or PVC-coated polyester.
  3. Weave: Basketweave
  4. Orientation on Shadeband: Up the bolt.
  5. Openness Factor: 5 percent.
  6. Color: As selected by Architect from manufacturer's full range.

## 2.4 ROLLER SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
  1. Between (Inside) Jamb Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
  2. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible, except as follows:
  1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

## PART 3 EXECUTION

### 3.1 EXAMINATION

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

### 3.2 ROLLER SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
- B. Roller Shade Locations: As indicated on Drawings.

### 3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

### 3.4 CLEANING AND PROTECTION

- A. Clean roller shade surfaces, after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

### 3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION

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## SECTION 123216 - PLASTIC LAMINATE-CLAD CASEWORK

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Plastic-laminate-clad cabinets and bookcases.
  - 2. Plastic-laminate-clad cubbies and storage units.
  - 3. Plastic-laminate-clad countertops.
  - 4. Casework hardware and accessories.
- B. Related Requirements:
  - 1. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking for anchoring casework.
  - 2. Section 092216 "Non-Structural Metal Framing" for reinforcements in metal-framed partitions for anchoring casework.
  - 3. Section 096513 "Resilient Base and Accessories" for resilient base applied to plastic-laminate-clad casework.

#### 1.3 DEFINITIONS

- A. Definitions in the AWI/AWMAC/WI's "Architectural Woodwork Standards" apply to the Work of this Section.

#### 1.4 COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that casework can be supported and installed as indicated.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include data for fire-retardant treatment from chemical-treatment manufacturer and certification by treating plant that treated materials comply with requirements.

- B. Shop Drawings: For plastic-laminate-clad casework. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Indicate locations of hardware and keying of locks.
  - 2. Indicate locations and types of service fittings.
  - 3. Indicate manufacturer's catalog numbers for casework.
  - 4. Indicate locations of blocking and reinforcements required for installing casework.
  - 5. Include details of utility spaces showing supports for conduits and piping.
  - 6. Include details of support framing system.
  - 7. Include details of exposed conduits, if required, for service fittings.
  - 8. Indicate locations of and clearances from adjacent walls, doors, windows, other building components, and other equipment.
  - 9. Include coordinated dimensions for equipment specified in other Sections.
  - 10. Show locations and sizes of cutouts and holes for items installed in plastic-laminate-clad countertops.
  - 11. Provide roughing in drawings for mechanical, plumbing and electrical services.
- C. Samples for Initial Selection: For casework and hardware finishes.
- D. Samples for Verification: For the following:
  - 1. Plastic Laminates: 12 by 12 inches (300 by 300 mm) for each type, color, pattern, and surface finish required.
    - a. Provide one Sample applied to core material with specified edge material applied to one edge.
  - 2. Thermoset Decorative Panels: 12 by 12 inches (300 by 300 mm) for each color, pattern, and surface finish.
    - a. Provide edge banding on one edge.
- E. Samples for Verification: Unless otherwise directed, approved full size samples may become part of the completed work, if in an undisturbed condition at time of substantial completion. Notify Architect of their exact locations. If not incorporated into the work, retain acceptable full size samples at Project site and remove when directed by Architect.
  - 1. One sample each of hinged and sliding doors.
  - 2. 6 inch (150 mm) square samples for each type of countertop material.
  - 3. One of each service fitting specified, complete with accessories and specified finish.
  - 4. One of each type of sink and accessory item specified.
  - 5. One of each type of hardware item specified.

## 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Provide copy of certificate confirming casework manufacturer is a Certified Participant in the AWI Quality Certification Program.
- B. Product Certificates: For the following:
  - 1. Composite wood and agrifiber products.
  - 2. High-pressure decorative laminate.
  - 3. Chemical-resistant, high-pressure decorative laminate.
  - 4. Adhesives.
- C. Product Test Reports for Casework: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of casework with requirements of specified product standard.
- D. Product Test Reports for Countertop Surface Material: Based on evaluation of comprehensive tests performed by a qualified testing agency, indicating compliance of countertop surface materials with requirements specified for chemical and physical resistance.

#### 1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain casework from single source from single manufacturer unless otherwise indicated.
- B. Delete last option in subparagraph below if premium-quality service fittings are required and service-fitting manufacturers are specified separately in Part 2.
- C. Retain first paragraph below if manufacturer's catalog numbers are used to designate cabinet types. Revise to suit office practice. Below may not be allowed for public projects.
- D. Flammable Liquid Storage: Where cabinets are indicated for solvent or flammable liquid storage, provide units that are listed and labeled as complying with requirements in NFPA 30 by FM Approvals.
- E. 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.
- F. Keying Conference: Conduct conference at Project site. Incorporate keying conference decisions into final keying requirements.
- G. Pre-installation Conference: Conduct conference at Project site.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect finished surfaces during handling and installation with protective covering of polyethylene film or other suitable material.
- B. Store countertops in areas where environmental conditions comply with requirements specified in "Field Conditions" Article.
- C. Keep surfaces of countertops covered with protective covering during handling and installation.

#### 1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install casework until building is enclosed, utility roughing in and wet work are complete and dry, and temporary HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Established Dimensions: Where casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.
- C. Field Measurements: Where casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes to allow for trimming and fitting.

#### 1.10 COORDINATION

- A. Coordinate layout and installation of framing and reinforcements for support of casework.
- B. Coordinate installation of casework with installation of equipment.

#### 1.11 EXTRA MATERIALS

- A. Furnish complete touchup kit for each type and color of casework provided. Include scratch fillers, stains, finishes, and other materials necessary to perform permanent repairs to damaged casework finish.
- B. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Cabinet Mounting Clips and Related Hardware: Quantity equal to 5 percent of amount installed, but no fewer than 20 of each type.

#### 1.12 WARRANTY

- A. The selected manufacturer must warrant for the life of the product in the application and location installed, starting at the date of acceptance or occupancy, whichever comes first, that all products sold under the contract referenced above shall be free from defects in material and workmanship. Purchaser shall notify the manufacturer's representative immediately of any defective product. The manufacturer shall have a reasonable opportunity to inspect the goods. The purchaser shall return no product until receipt by purchaser of written shipping instructions from the manufacturer.

## PART 2 PRODUCTS

### 2.1 GENERAL REQUIREMENTS FOR CASEWORK

- A. Quality Standard: Unless otherwise indicated, comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards" for grades of casework indicated for construction, finishes, installation, and other requirements.
  - 1. Grade: Custom
  - 2. Provide inspections of casework fabrication and installation together with labels and certificates from AWI certification program indicating that casework complies with requirements of grades specified.
- B. Product Designations: Drawings indicate sizes, configurations, and finish materials of manufactured plastic-laminate-clad casework by referencing designated manufacturer's catalog numbers. Other manufacturers' casework of similar sizes and door and drawer configurations, of same finish materials, and complying with the Specifications may be considered. See Section 016000 "Product Requirements."
- C. Product Designations: Drawings indicate configurations of manufactured plastic-laminate-clad casework by referencing designations of Casework Design Series numbering system in the Appendix of the AWI/AWMAC/WI's "Architectural Woodwork Standards."

### 2.2 PLASTIC-LAMINATE-CLAD CABINETS, BOOKCASES, CUBBIES, AND STORAGE UNITS

- A. Design: Frameless cabinet construction with the following door and drawer-front style:
  - 1. Reveal overlay with radiused edges.
- B. Grain Direction for Wood-Grain Plastic Laminate:
  - 1. Doors: Vertical with continuous vertical matching.
  - 2. Drawer Fronts: Vertical with continuous vertical matching.
  - 3. Face Frame Members: Lengthwise.
  - 4. End Panels: Vertical.
  - 5. Bottoms and Tops of Units: Side to side.
  - 6. Knee Space Panels: Vertical.
  - 7. Aprons: Horizontal.

C. Exposed Materials:

1. Plastic-Laminate Grade: HGS, HGF, VGS, and VFP.
  - a. Colors and Patterns: As selected by Architect from manufacturer's full range.
2. Edge-banding: PVC
  - a. PVC Edge-banding Color: As selected by Architect from casework manufacturer's full range.

D. Semi-exposed Materials:

1. Plastic Laminate: Grade VGS unless otherwise indicated. Provide plastic laminate for semi-exposed surfaces unless otherwise indicated.
  - a. Colors and Patterns: As selected by Architect from manufacturer's full range.
  - b. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.
2. Thermoset Decorative Panels: Provide thermoset decorative panels for semi-exposed surfaces unless otherwise indicated.
  - a. Colors and Patterns: As selected by Architect from manufacturer's full range.
  - b. Provide plastic laminate of same grade as exposed surfaces for interior faces of doors and drawer fronts and other locations where opposite side of component is exposed.
3. Hardboard: Use only for cabinet backs where exterior side of back is not exposed.
4. Metal for Steel Drawer Pans: Cold-rolled, carbon-steel sheet complying with ASTM A 1008/A 1008M; matte finish; suitable for exposed applications.
5. Unless otherwise indicated, provide specified edge-banding on all semi-exposed edges.

E. Concealed Materials:

1. Solid Wood: With no defects affecting strength or utility.
2. Plywood: Hardwood plywood.
3. Plastic Laminate: Grade BKL.
4. Particleboard.
5. MDF.
6. Hardboard.

## 2.3 CABINET HARDWARE AND ACCESSORIES

A. Hardware, General: Unless otherwise indicated, provide manufacturer's standard satin-finish, commercial-quality, heavy-duty hardware.

1. Use threaded metal or plastic inserts with machine screws for fastening to particleboard except where hardware is through-bolted from back side.

- B. Butt Hinges: Stainless steel, semi-concealed, 5-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide 2 hinges for doors less than 48 inches (1220 mm) high and provide no less than 3 hinges for doors more than 48 inches (1220 mm) high.
- C. Wire Pulls: Solid stainless-steel wire pulls, fastened from back with two screws.
  - 1. For sliding doors, provide recessed stainless-steel flush pulls.
  - 2. Provide two pulls for drawers more than 24 inches (600 mm) wide.
- D. Semi-recessed Pulls: Plastic. For sliding doors, provide recessed plastic flush-pulls. Provide two pulls for drawers more than 24 inches (600 mm) wide.
- E. Door Catches: Nylon-roller spring catch. Provide 2 catches on doors more than 48 inches (1220 mm) high.
- F. Door and Drawer Bumpers: Self-adhering, clear silicone rubber.
  - 1. Doors: Provide one bumper at top and bottom of closing edge of each swinging door.
  - 2. Drawers: Provide one bumper on back side of drawer front at each corner.
- G. Drawer Slides: Side mounted, epoxy-coated steel, self-closing; designed to prevent rebound when drawers are closed; complying with BHMA A156.9, Type B05091.
  - 1. Provide Grade 1HD-100; for drawers, not more than 6 inches (150 mm) high and 24 inches (600 mm) wide.
  - 2. Provide Grade 1HD-100; for drawers, more than 6 inches (150 mm) high or 24 inches (600 mm) wide.
  - 3. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Full extension, ball-bearing type.
- H. Drawer and Hinged-Door Locks: Cam type, 5-pin tumbler, brass with chrome-plated finish, and complying with BHMA A156.11, Grade 1.
  - 1. Provide a minimum of two keys per lock and two master keys.
  - 2. Provide locks on every door or set of doors.
  - 3. Master Key System: Key all locks to be operable by master key.
- I. Sliding-Door Hardware Sets: Manufacturer's standard, to suit type and size of sliding-door unit.
- J. Adjustable Shelf Supports: Mortise-type, powder-coated steel standards and shelf rests complying with BHMA A156.9, Type B04071 and Type B04091.

## 2.4 PLASTIC-LAMINATE-CLAD COUNTERTOPS

- A. Quality Standard: Unless otherwise indicated, comply with the "Architectural Woodwork Standards" for grades of plastic-laminate-clad countertops indicated for construction, finishes, installation, and other requirements.

1. Provide inspections of fabrication and installation together with labels and certificates from AWI certification program indicating that countertops comply with requirements of grades specified.
  2. The Contract Documents contain requirements that are more stringent than the referenced quality standard. Comply with requirements of Contract Documents in addition to those of the referenced quality standard.
- B. Grade: Custom
- C. High-Pressure Decorative Laminate: NEMA LD 3, Grade HGS, HGP, and HGF.
1. Manufacturer: Subject to compliance with requirements, provide high-pressure decorative laminates by one of the following:
    - a. Abet Laminati, Inc.
    - b. Arborite; Division of ITW Canada, Inc.
    - c. Formica Corporation.
    - d. Lamin-Art, Inc.
    - e. Nevamar Company, LLC; Decorative Products Div.
    - f. Wilsonart International; Div. of Premark International, Inc.
- D. Chemical-Resistant, High-Pressure Decorative Laminate: NEMA LD 3, Grade HGP, and as follows:
1. Laminate has the following ratings when tested with indicated reagents according to NEMA LD 3, Test Procedure 3.9.5:
    - a. Moderate Effect:
      - 1) Nitric Acid (30 Percent), Sulfuric Acid (77 Percent), Hydrochloric Acid (37 Percent), and Phenol (85 Percent):
    - b. No Effect:
      - 1) Phosphoric Acid (75 Percent), Acetic Acid (98 Percent), Formaldehyde, Ethyl Acetate, Ethyl Ether, Benzene, Xylene, Butyl Alcohol, Furfural, Methyl Ethyl Ketone, Sodium Hydroxide (25 Percent), Sodium Sulfide (15 Percent), Ammonium Hydroxide (28 Percent), Zinc Chloride, Gentian Violet, and Methyl Red.
- E. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
1. As selected by Architect from manufacturer's full range in the following categories:
    - a. Solid colors, gloss or matte finish.
    - b. Solid colors with core same color as surface, gloss or matte finish.
    - c. Wood grains, gloss or matte finish with grain running parallel to length of countertop.
    - d. Patterns, gloss or matte finish.
- F. Edge Treatment: 0.08 inch (2 mm) PVC edging.



- G. Core Material: Particleboard or Fire-retardant Particleboard as required.
- H. Core Material at Sinks: Particleboard made with exterior glue.
- I. Core Thickness: 1-1/8 inch (29 mm).
  - 1. Build up countertop thickness to 1-1/2 inches (38 mm) at front, back, and ends with additional layers of core material laminated to top.
- J. Backer Sheet: Provide plastic-laminate backer sheet, NEMA LD 3, Grade BKL, on underside of countertop substrate.
- K. Paper Backing: Provide paper backing on underside of countertop substrate.

## 2.5 CASEWORK MATERIALS

- A. Adhesives: Do not use adhesives that contain urea formaldehyde.
- B. Adhesive for Bonding Plastic Laminate: PVA.
  - 1. Adhesive for Bonding Edges: adhesive specified above for faces.
- C. Maximum Moisture Content for Lumber: 7 percent for hardwood and 12 percent for softwood.
- D. Hardwood Plywood: HPVA HP-1, particleboard core except where veneer core is indicated, made without urea formaldehyde.
- E. Softwood Plywood: DOC PS 1.
- F. Particleboard: ANSI A208.1, Grade M-2.
- G. Particleboard: Straw-based particleboard complying with ANSI A208.1, Grade M-2, except for density.
  - 1. Source Limitations: Obtain from single source from single manufacturer.
- H. MDF: Medium-density fiberboard, ANSI A208.2, Grade 130.
- I. Hardboard: ANSI A135.4, Class 1 tempered.
- J. Composite Wood and Agrifiber Products: Provide materials that comply with requirements of referenced quality standard for each type of countertop and quality grade specified unless otherwise indicated.
- K. Plastic Laminate: High-pressure decorative laminate complying with NEMA LD 3.
  - 1. Source Limitations: Obtain from single source from single manufacturer.
- L. PVC Edge-banding for Plastic Laminate: Rigid PVC extrusions, through color with satin finish, 0.12 inch (3 mm) thick at doors and drawer, 0.04 inch (1 mm) thick elsewhere.

- M. Thermoset Decorative Panels: Particleboard or MDF finished with thermally fused, melamine-impregnated decorative paper and complying with requirements of NEMA LD 3, Grade VGL, for Test Methods 3.3, 3.4, 3.6, 3.8, and 3.10.
  - 1. Edge-banding for Thermoset Decorative Panels: PVC or polyester edge-banding matching thermoset decorative panels.
- N. Glass for Glazed Doors: Clear tempered glass complying with ASTM C 1048, Kind FT, Condition A, Type I, Class 1, Quality-Q3; not less than 3/16 inch thick.

## 2.6 FIRE-RETARDANT-TREATED MATERIALS

- A. Fire-Retardant-Treated Materials, General: Where fire-retardant-treated materials are indicated, use materials that are acceptable to authorities having jurisdiction and with fire-test-response characteristics specified as determined by testing identical products according to test method indicated by a qualified testing agency.
  - 1. Use treated materials that comply with requirements of referenced quality standard. Do not use materials that are warped, discolored, or otherwise defective.
  - 2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
  - 3. Identify fire-retardant-treated materials with appropriate classification marking of qualified testing agency in the form of removable paper label or imprint on surfaces that will be concealed from view after installation.
- B. Fire-Retardant Particleboard: Made from softwood particles and fire-retardant chemicals mixed at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 25 or less when tested according to ASTM E 84.
  - 1. For panels 3/4 inch (19 mm) thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: modulus of rupture, 1600 psi (11 MPa); modulus of elasticity, 300,000 psi (2070 MPa); internal bond, 80 psi (550 kPa); and screw-holding capacity on face and edge, 250 and 225 lbf (1100 and 1000 N), respectively.
  - 2. For panels 13/16 to 1-1/4 inches (20 to 32 mm) thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: modulus of rupture, 1300 psi (9 MPa); modulus of elasticity, 250,000 psi (1720 MPa); linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 250 and 175 lbf (1100 and 780 N), respectively.
- C. Fire-Retardant MDF: Medium-density fiberboard panels complying with ANSI A208.2, made from softwood fibers, synthetic resins, and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread index of 25 or less and smoke-developed index of 200 or less according to ASTM E 84.

## 2.7 FABRICATION

- A. Plastic-Laminate-Clad Cabinet Construction: As required by referenced quality standard, but not less than the following:
1. Bottoms and Ends of Cabinets, and Tops of Wall Cabinets and Tall Cabinets: 3/4 inch (19 mm) particleboard.
  2. Shelves: 3/4 inch (19 mm) thick particleboard.
  3. Backs of Casework: 1/4 inch (6.4 mm) thick, veneer-core hardwood plywood dadoed into sides, bottoms, and tops where not exposed.
  4. Drawer Fronts: 3/4 inch (19 mm) particleboard.
  5. Drawer Sides and Backs: 1/2 inch (13 mm) thick particleboard with glued dovetail or multiple-dowel joints.
  6. Drawer Bottoms: 1/4 inch (6.4 mm) thick particleboard glued and dadoed into front, back, and sides of drawers. Use 1/2 inch (13 mm) material for drawers more than 24 inches (600 mm) wide.
  7. Drawer Bodies: Steel drawer pans formed from 0.0359 inch (0.9 mm) thick metal, metallic phosphate treated, and finished with manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat with a minimum dry film thickness of 1 mil (0.025 mm) for topcoat and 2 mils (0.05 mm) for system.
  8. Doors Less Than 48 Inches (1220 mm) High: 3/4 inch (19 mm) thick, with particleboard cores.
  9. Doors More Than 48 Inches (1220 mm) High: 1-1/8 inches (29 mm) thick, with particleboard cores.
  10. Stiles and Rails of Glazed Doors Less Than 48 Inches (1220 mm) High: 3/4 inch (19 mm) thick, with particleboard cores.
  11. Stiles and Rails of Glazed Doors More Than 48 Inches (1220 mm) High: 1-1/8 inches (29 mm) thick, with particleboard cores.
- B. Plastic-Laminate-Clad Countertop Construction: As required by referenced quality standard, but not less than the following:
1. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.
  2. Fabricate countertops to dimensions, profiles, and details indicated. Provide front and end overhang of 1 inch (25 mm) over base cabinets. Ease edges to radius indicated for the following:
    - a. Solid-Wood (Lumber) Members: 1/16 inch (1.5 mm) unless otherwise indicated.
  3. Complete fabrication, including assembly, 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.

- a. Notify Architect seven days in advance of the dates and times countertop fabrication will be complete.
  - b. 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 before disassembling for shipment.
- 4. Shop cut openings to maximum extent possible to receive 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.
  - a. Seal edges of cutouts by saturating with varnish.
- C. Filler Strips: Provide as needed to close spaces between casework and walls, ceilings, and equipment. Fabricate from same material and with same finish as casework.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of framing and reinforcements, and other conditions affecting performance of the Work.
- B. Before installation, condition countertops to average prevailing humidity conditions in installation areas.
- C. Before installing countertops, examine shop-fabricated work for completion and complete work as required, including removal of packing.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION OF PLASTIC-LAMINATE-CLAD CASEWORK

- A. Grade: Install casework to comply with same quality standard grade as item to be installed.
- B. Install casework level, plumb, and true in line; shim as required using concealed shims. Where casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical.
- C. Base Cabinets: Set cabinets straight, level, and plumb. Adjust subtops within 1/16 inch (1.5 mm) of a single plane. Align similar adjoining doors and drawers to a tolerance of 1/16 inch (1.5 mm). Bolt adjacent cabinets together with joints flush, tight, and uniform.

- D. Wall Cabinets: Hang cabinets straight, level, and plumb. Adjust fronts and bottoms within 1/16 inch (1.5 mm) of a single plane. Fasten cabinets to hanging strips, masonry, framing, wood blocking, or reinforcements in walls and partitions. Align similar adjoining doors to a tolerance of 1/16 inch (1.5 mm).
- E. Fasten casework to adjacent units and to masonry, framing, wood blocking, or reinforcements in walls and partitions to comply with the AWI/AWMAC/WI's "Architectural Woodwork Standards."
- F. Install hardware uniformly and precisely. Set hinges snug and flat in mortises unless otherwise indicated. Adjust and align hardware so moving parts operate freely and contact points meet accurately. Allow for final adjustment after installation.
- G. Adjust operating hardware so doors and drawers operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.
- H. Assemble countertops and complete fabrication at Project site to the extent that it was not completed in the shop.
  - 1. Provide cutouts for 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. Seal edges of cutouts by saturating with varnish.
- I. Field Jointing: Where possible, make in the same manner as shop jointing, using dowels, splines, adhesives, and fasteners recommended by manufacturer. Prepare edges to be joined in shop so Project-site processing of top and edge surfaces is not required. Locate field joints where shown on Shop Drawings.
  - 1. Secure field joints in countertops with concealed clamping devices located within 6 inches (150 mm) of front and back edges and at intervals not exceeding 24 inches (600 mm). Tighten according to manufacturer's written instructions to exert a constant, heavy-clamping pressure at joints.
- J. Scribe and cut countertops to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.
- K. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical-treatment manufacturer's written instructions, including those for adhesives used to install woodwork.
- L. Countertop Installation: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
  - 1. Install countertops level and true in line. Use concealed shims as required to maintain not more than a 1/8 inch in 96 inches (3 mm in 2400 mm) variation from a straight, level plane.

2. Secure backsplashes to tops with concealed metal brackets at 16 inches (400 mm) o.c. and to walls with adhesive, where applicable.
3. Seal joints between countertop and backsplash, if any, and joints where countertop and backsplash abut walls with mildew-resistant silicone sealant or another permanently elastic sealing compound recommended by countertop material manufacturer.

### 3.3 CLEANING

- A. Repair or remove and replace defective work as directed on completion of installation.
- B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas to match original factory finish, as approved by Architect.
- C. Protection: Provide Kraft paper or other suitable covering over countertop surfaces, taped to underside of countertop at a minimum of 48 inches (1220 mm) o.c. Remove protection at Substantial Completion.

END OF SECTION

## SECTION 123661 - SOLID SURFACING MATERIALS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Solid surface material sills and stools.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For sill and stool materials.
- B. Shop Drawings: For sills and stools. Show materials, profiles, and methods of joining.
  - 1. Show locations and details of joints.
  - 2. Show direction of directional pattern, if any.
- C. Samples for Initial Selection: For each type of material exposed to view.
- D. Samples for Verification: For the following products:
  - 1. Sills and stools, 6 inches square.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For fabricator.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For solid surface materials to include in maintenance manuals. Include Product Data for care products used or recommended by Installer and names, addresses, and telephone numbers of local sources for products.

#### 1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate materials similar to that required for this Project, and whose products have a record of successful in-service performance.
- B. Installer Qualifications: Fabricator of solid surface materials.
- C. Mockups: Build mockups to demonstrate aesthetic effects and to set quality standards for fabrication and execution.
  - 1. Build mockup of typical sills and stools as shown on Drawings.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.6 FIELD CONDITIONS

- A. Field Measurements: Verify dimensions of solid surfacing sills and stools by field measurements before fabrication is complete.

## PART 2 PRODUCTS

### 2.1 SOLID SURFACE MATERIALS

- A. Basis of Design Product: Subject to compliance with requirements, 1/2-inch thick homogeneous-filled plastic resin manufactured by Wilsonart LLC, or a comparable product by one of the following:
  1. Formica Corporation
  2. Meganite
  3. Relang International LLC
    - a. Type: Provide Standard type.
    - b. Colors: As selected by Architect from manufacturer's full range.

### 2.2 FABRICATION

- A. Fabricate sills and stools according to solid surface material manufacturer's written instructions and to the AWI/AWMAC/WI's "Architectural Woodwork Standards."
  1. Grade: Custom.
- B. Configuration:
  1. Front: Straight, beveled edge
- C. Sills and Stools: 1/2-inch thick, solid surface material.
- D. Fabricate materials with shop-applied edges unless otherwise indicated. Comply with solid surface material manufacturer's written instructions for adhesives, sealers, fabrication, and finishing.
- E. Joints: Fabricate sills and stools without joints.

### 2.3 INSTALLATION MATERIALS

- A. Adhesive: Product recommended by solid surface material manufacturer.
- B. Sealant for Sills and Stools: Comply with applicable requirements in Section 079200 "Joint Sealants."



## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates to receive solid surface materials and conditions under which solid surface materials will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of sills and stools.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install sills and stools for full length of each window unit, securing to substrates with concealed fasteners and specified adhesive.
- B. Provide minimum 1/8-inch expansion gap on both sides of sills and stools. Fill gap with specified joint sealant.
- C. Install solid surfacing components plumb, level, and true with edges eased and sanded smoothed. Use woodworking and specialized fabrication tools acceptable to manufacturer.

### 3.3 REPAIRS

- A. Remove and replace solid surfacing components that are damaged and cannot be satisfactorily repaired.

### 3.4 CLEANING AND PROTECTION

- A. Clean solid surfacing components according to manufacturer's published maintenance instructions. Completely remove excess adhesives and sealants from finished surfaces.
- B. Protect completed work from damage during remainder of construction period.

END OF SECTION

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## SECTION 124813 - ENTRANCE FLOOR MATS AND FRAMES

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Roll-up entrance mats.
  - 2. Resilient entrance mats and recessed frames.

#### 1.3 COORDINATION

- A. Coordinate size and location of recesses in concrete to receive floor mats and frames.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for floor mats and frames.
- B. Shop Drawings:
  - 1. Items penetrating floor mats and frames, including door control devices.
  - 2. Divisions between mat sections.
  - 3. Perimeter floor frames.
  - 4. Direction of traffic.
  - 5. Anchors and accessories.
- C. Samples: For the following products, in manufacturer's standard sizes:
  - 1. Floor Mat: 12 inch square, assembled sections of floor mat.
  - 2. Tread Rail: 12 inch long sample of each type and color.
  - 3. Frame Members: 12 inch long sample of each type and color.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For floor mats and frames to include in maintenance manuals.

#### 1.6 PROJECT CONDITIONS

- A. Field Measurements: Indicate measurements on Shop Drawings.

## 1.7 COORDINATION

- A. Coordinate frame installation with concrete construction to ensure recess and frame anchorage are accurate and that the base is level and flat. Defer frame installation until building enclosure is complete and related interior finish work is in progress.

## PART 2 PRODUCTS

### 2.1 ENTRANCE FLOOR MATS AND FRAMES, GENERAL

- A. Source Limitations: Obtain floor mats and frames through one source from a single manufacturer.
- B. Structural Performance: Provide roll-up rail mats and frames capable of withstanding the following loads and stresses within limits and under conditions indicated:
  - 1. Uniform floor load of 300 lbf/sq. ft.
  - 2. Wheel load of 350 lb per wheel.
- C. Accessibility Standard: Comply with applicable provisions in the DOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

### 2.2 ROLL-UP ENTRANCE MATS

- A. Basis of Design Product: Subject to compliance with requirements, provide Premier Heavy Duty entry mat by Waterhog Floor Mats.
  - 1. Size: As indicated on drawings.
  - 2. Backing: Smooth rubber, for hard surfaces, with improved traction.
  - 3. Color: As selected by Architect from manufacturer's full range.
  - 4. Pattern: Diamond shaped.
  - 5. Characteristics: Water damming border and 3/8" raised nub surface.

### 2.3 RESILIENT ENTRANCE MATS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Construction Specialties, Inc. Model G4 PediTred with Tapered Angle Frame with Drain Pan or a comparable product by one of the following:
  - 1. Amarco Products.
  - 2. American Floor Mats.
  - 3. C/S Group.
  - 4. Durable Corporation.
  - 5. JL Industries, Inc.; a division of the Activar Construction Products Group.
  - 6. Kadee Industries, Inc.

7. Mats Incorporated.
  8. Musson Rubber Co.
  9. Pawling Corporation.
  10. Reese Enterprises, Inc.
  11. U.S. Mat & Rubber Corporation.
- B. Resilient Mats: 7/16 inch thick, manufactured from aluminum alloy tread rail extrusions spaces at 1 1/2" centers, connected by perforated ball and socket aluminum hinge to allow roll up of mat. Tread rails to include continuous flexible cushion for contact with substrate and a carpet tread rail inset for exposed walking surface.
1. Tread Material: Aluminum, ASTM B221, Alloy 6061-T6 or Alloy 6063-T5 for extrusions.
  2. Tread Color: Mill finish.
  3. Tread Rail Inset:
    - a. Basis of Design Product: MonoTuft HD Carpet; Fibers shall include a minimum of 100, 12 mil monofilament fibers per square inch. Each carpet fiber and monofilament shall be fusion-bonded to a rigid two-ply backing to prevent fraying and supplied in continuous splice-free lengths. Anti-static carpet fibers shall contain antimicrobial additive and be treated with Scotchgard® to reduce soiling.
  4. Color: As selected by Architect from manufacturer's full range.
  5. Mat Size: As indicated on drawings.

## 2.4 FRAMES

- A. Recessed Frames: Manufacturer's standard extrusion.
1. Frame Type: Tapered Angle Frame.
  2. Extruded Aluminum: ASTM B221, Alloy 6061-T6 or Alloy 6063-T5, T6, or T52.
  3. Color: Mill Finish.
  4. Accessories: Manufacturer's standard drain pan.

## 2.5 CONCRETE FILL AND GROUT MATERIALS

- A. Provide concrete fill and grout equivalent in strength to cast-in-place concrete slabs for recessed mats and frames. Use aggregate no larger than one-third fill thickness.

## 2.6 FABRICATION

- A. Floor Mats: Shop fabricate units to greatest extent possible in sizes indicated. Unless otherwise indicated, provide single unit for each mat installation; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints.

- B. Recessed Frames: As indicated, for permanent recessed installation, complete with corner pins or reinforcement and anchorage devices.
  - 1. Fabricate edge-frame members in single lengths or, where frame dimensions exceed maximum available lengths, provide minimum number of pieces possible, with hairline joints equally spaced and pieces spliced together by straight connecting pins.
- C. Coat concealed surfaces of aluminum frames that contact cementitious material with manufacturer's standard protective coating.

## 2.7 ALUMINUM FINISHES

- A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates and floor conditions for compliance with requirements for location, sizes, minimum recess depth, and other conditions affecting installation of floor mats and frames.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install recessed mat frames and mats to comply with manufacturer's written instructions so that tops of mats will be flush with adjoining finished flooring. Set mats with tops at height recommended by manufacturer for most effective cleaning action; coordinate tops of mat surfaces with bottoms of doors that swing across mats to provide clearance between door and mat.
  - 1. Coordinate with other trades as required.
  - 2. Install necessary shims, spacers, and anchorages for proper location, and secure attachment of frames.
  - 3. Install grout and fill around frames and, if required to set mat tops at proper elevations, in recesses under mats. Finish grout and fill smooth and level.
- B. Install surface-type units to comply with manufacturer's written instructions; coordinate with entrance locations and traffic patterns.

### 3.3 PROTECTION

- A. After completing frame installation and concrete work, provide temporary filler of plywood or fiberboard in recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.
- B. Defer installation of floor mats/grids until time of substantial completion of project.

END OF SECTION

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## SECTION 220500 - GENERAL PLUMBING REQUIREMENTS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and all Division 22 Sections.

#### 1.2 PLANS AND SPECIFICATIONS

- A. All work under this title, on drawings or specified, is subject to the general and special contract conditions for the entire project, and the contractor for this portion of the work is required to refer especially thereto, and to the architectural drawings.
- B. Drawings are diagrammatic and specifications are complementary and must be so interpreted to determine the full scope of work under this heading. Wherever any material, article, operation or method is either specified or shown on the drawings, this contractor is required to provide each item and perform each prescribed operation according to the designate quality, qualification or condition, furnishing all necessary labor, equipment or incidentals.
- C. Wherever the designation "Architect" appears, it shall imply Architect or Engineer. Wherever the term "Contractor" or "PC" appears, it shall imply the Contractor responsible for Division 22, Plumbing Work.

#### 1.3 CONFLICTS

- A. If, in the interpretation of contract documents, it appears that the drawings and specifications are not in agreement, the Contractor is to contact the Engineer. The Engineer shall be the final authority. Addenda supersede the provisions which they amend.
- B. In the absence of a written clarification by the engineer, the Contractor must install his work in accordance with the more stringent condition. Contractor assumes full responsibility for any and all items furnished and installed without the written approval by the Architect or Engineer.

#### 1.4 DIMENSIONS, LAYOUTS AND OBSTACLES

- A. Verify dimensions and elevations from actual field measurements after building construction has sufficiently progressed.

- B. Assume full and final responsibility for the accuracy of any or all work performed under this Division and make repairs and corrections as required or directed at no extra cost to the Owner.
- C. Layouts of piping and equipment shown on drawings are diagrammatic and shall be construed as such. DO NOT SCALE DRAWINGS. Contractor shall field verify all existing conditions prior to fabrication and installation of material. It is recommended that the contractor verify all existing conditions prior to submitting a proposal. Lack of field verification does not constitute a basis for additional monies during construction. Contractor assumes full responsibility for completeness of installation including coordination of work with other trades.
- D. Make actual installations in accord with said layouts, but with necessary deviations as directed or required by job conditions and field measurements in order to produce a thoroughly integrated and practical installation. . Make deviations only with specific approval of the Engineer/Architect.
- E. Take particular care to coordinate all work under this Division to prevent conflict and remove and relocate work as may be made necessary by such conflict at no extra cost to the Owner.
- F. Unless expressly permitted by the Engineer/Architect or shown otherwise on the Drawings, all piping and similar items shall be installed so that they are concealed except as permitted by the Engineer/Architect in service rooms noted on the Drawings.
- G. Fixtures and equipment may be relocated six (6) feet in any direction from locations indicated on plans, before roughing-in, with no change in contract price.

#### 1.5 REVIEW OF MATERIAL

- A. Items specified have been checked by the Engineer for performance and space limitation.
- B. In order for Engineer to consider "equal", Contactor must certify by letter that he has checked the product for conformance to specifications and space limitations and assumes full responsibility thereafter.
- C. Substitutions are defined as any manufacturer and/or model not indicated in drawings or specifications. Requests for substitutions must be made in writing ten (10) days prior to bid date so that an addendum may reach all contractors.

- D. If substitutions are proposed after the bids are received, the Contractor shall state amount of credit to the Owner for substitution. Substitutions that are considered equal by the Contractor and carried in bid without approval by Engineer shall be the responsibility of the Contractor. The Engineer and/or Owner shall not be made liable or responsible for losses incurred by the Contractor, due to the rejection of said items for installation.
- E. Where equipment requiring different arrangement or connections other than as indicated is acceptable, it shall be the responsibility of this Contractor to furnish revised layouts, and install the equipment to operate properly and in harmony with the intent of the drawings and specifications. All changes in the work required by the different arrangement shall be done at no additional cost to the Owner, including but not limited to structural steel modifications. Control and power wiring modifications required by Contractor, imposed modifications, and the additional cost of these modifications, shall be the responsibility of this Contractor.

#### 1.6 PERMITS, CODES AND ORDINANCES

- A. The Contractor shall arrange and pay for all permits, inspections, etc., as required by local utilities or applicable agencies.
- B. All work and material shall be in complete accordance with the ordinances, regulations, codes, etc., of all political entities exercising jurisdictions.

#### 1.7 COORDINATION WITH OTHER TRADES

- A. Check plumbing work with all other trades.
- B. Anticipate and avoid interferences with other trades.
- C. Take particular care to coordinate all piping, ductwork, plumbing and major electrical components above ceiling, to prevent conflict. Remove and relocate work as may be made necessary by such conflict, at no extra cost to the Owner.
- D. Obtain decision for approval from project Engineer for proposed group installation before proceeding, and for clearance in structure and finish of the building.
- E. Running piping over electrical equipment and in elevator machine rooms is prohibited.
- F. The Contractor shall coordinate with, receive and install, Owner furnished equipment where indicated.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Delivery of Materials: Make provisions for delivery and safe storage of all materials. Check and properly receipt material to be "furnished by others" to contractor and assume full responsibility for all materials while in storage with full visible identification and information.

#### 1.9 PROJECT CONDITIONS

- A. Coordination: Field verify existing conditions that will determine exact locations, distances, levels, dimensions, elevations, etc. Review all drawings of other trades and report any conflicts to the Architect/Engineer which will affect the project cost. Lack of field verification does not constitute a basis for additional monies during construction. Contractor assumes full responsibility for completeness of installation including coordination of work with other trades.

#### 1.10 MISCELLANEOUS SUPPORT

- A. Contractor is responsible for providing all miscellaneous support components necessary for properly supporting equipment including hangers, rods, anchors, steel, etc. PRODUCTS (not used)

### PART 2 EXECUTION

#### 2.1 INSTALLATION

- A. Comply with manufacturer's written installation, operations and maintenance instructions for general installation requirements and procedures.

END OF SECTION

## SECTION 220502 - PLUMBING DEMOLITION

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Description of Work: Provide plumbing removal work as indicated and as required for removal and/or abandonment of systems, equipment and fixtures, etc. made obsolete by this Project, and as required for removal and remodeling by other trades.

#### 1.2 EXISTING CONDITIONS

- A. General: In general, existing plumbing systems, equipment and fixtures are not shown on the Drawings unless pertinent to the demolition and/or remodeling work. Existing conditions, where indicated, are based on casual field observations and/or historical plans prepared as part of original building fit-out, and must be verified. Report any discrepancies to the Engineer before disturbing the existing installation.
- B. Examination: Prior to bidding, examine the site to determine all actual observable conditions. No additional compensation will be granted on account of extra work made necessary by the Contractor's failure to investigate such existing conditions.

#### 1.3 COORDINATION

- A. Adjoining Areas: It is expected that the Contractor understands that adjoining areas of the building (or project site) must remain in operation and mechanical systems and services must remain in operation at all times, unless specifically approved otherwise.
- B. Scheduling: Plumbing removal work shall be scheduled in conjunction with the other trades. Contractor cooperation will be expected under all conditions.
- C. Area Limits: Construction traffic and removal of debris will be limited to specific areas and routes. Confirm with the Owner.

#### 1.4 ADJACENT MATERIALS

- A. Protection: During execution of removal work, primary consideration shall be given to protecting from damage, building structure, furnishings, finishes and the like, which are not specifically indicated to be removed.
- B. Repairs: Existing items or surfaces to remain, which are damaged as a result of this work shall be refinished, repaired or replaced to the satisfaction of the Owner, at no cost to the Contract.

## 1.5 TRANSIENT SERVICES

- A. Locate and identify any and all plumbing services passing through the project area which serve areas outside the work limits.
- B. Maintain all plumbing services to areas outside the work limits unless specifically authorized otherwise in writing by the Engineer or Owner's Representative. When transient services must be interrupted, provide temporary services for affected areas outside the work limits.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Patching: Materials used for patching shall be in conformance with the applicable sections of the Project Manual. Where materials are not specifically described, but required for proper completion of the Work, they shall be as selected by the Contractor, subject to approval of the Engineer.

## PART 3 EXECUTION

### 3.1 INSPECTION/VERIFICATION

- A. Inspection: Before commencing work of this Section, carefully inspect the project site and become familiar with existing systems and conditions.
- B. Items to be Salvaged: Verify with the Engineer and Owner's Representative, all systems, materials and equipment which are to be salvaged, and those which must be removed. The Owner reserves the right to salvage any or all existing plumbing materials and equipment at the project site.

### 3.2 COORDINATION

- A. Coordinate removal work with other trades, where applicable.

### 3.3 DEMOLITION

- A. General: Remove plumbing equipment, piping, fixtures and related materials within the project work limits, as indicated.
- B. Disconnections: Disconnect all plumbing work located in walls, ceilings or floors scheduled for removal. Disconnect plumbing connections equipment being removed by other trades.

- C. Protection: Perform all removal work in such a manner so that damage to adjacent items and surfaces is minimized.
- D. Patching: When plumbing materials are removed, patch and finish surfaces to remain to match surrounding surfaces.

### 3.4 EXISTING plumbing WORK TO REMAIN

- A. General: Protect and maintain access to existing plumbing work which must remain. Reinstall existing plumbing work where disturbed.
- B. Reconnections: Where plumbing work in adjoining areas or plumbing work indicated to remain, becomes disconnected or affected by demolition work, reconnect as required, to restore original operation. Restoration work to comply with requirements for new work.

### 3.5 EXISTING plumbing WORK TO BE RELOCATED

- A. General: Disconnect, remove, reinstall and reconnect existing equipment indicated to be relocated and where require to accommodate remodeling or new construction. Extend existing installations as required. Materials and methods used for relocations and extensions to conform to requirements for new work.

### 3.6 SHUTDOWNS

- A. General: All shutdowns to existing plumbing services to be scheduled and approved, in writing, by the Owner.

### 3.7 DISPOSITION OF EXISTING MATERIALS AND EQUIPMENT

- A. Items to Salvage: Material and equipment which is indicated (or directed by Owner) to be salvaged, shall be carefully removed and stored where directed on the site.
- B. Items to Reuse/Relocate: Carefully remove and store on site, all material and equipment indicated to be reused or relocated. Thoroughly clean, and make any necessary minor repairs to such equipment, prior to installation.
- C. Items to Remove: Remove and legally dispose of all other materials and debris resulting from demolition work on a daily basis.

### 3.8 CLEANING

- A. Remove from the Project Site all dirt, dust and debris resulting from removal operations daily. Refuse shall not be allowed to block or otherwise impair circulation in corridors, stairs, sidewalks, roadways or other traffic areas.

END OF SECTION



## SECTION 220529 - SUPPORTS AND SLEEVES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Perform all Work required to provide and install supports, hangers, anchors, sleeves and bases for all pipe, duct, equipment, system components and accessories, indicated by the Contract Documents with all supplementary items necessary for complete, code compliant and approved installation.

#### 1.2 REFERENCE STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:
  - 1. International Plumbing Code.
  - 2. International Fuel Gas Code.
  - 3. ASME B31.2 – Fuel Gas Piping.
  - 4. ASME B31.9 – Building Services Piping.
  - 5. ASTM F708 – Design and Installation of Rigid Pipe Hangers.
  - 6. MSS SP58 – Pipe Hangers and Supports - Materials, Design and Manufacturer.
  - 7. MSS SP69 – Pipe Hangers and Supports - Selection and Application.
  - 8. MSS SP89 – Pipe Hangers and Supports - Fabrication and Installation Practices.
  - 9. MSS SP-90 – Guidelines on Terminology for Pipe Hangers and Supports.

#### 1.3 QUALITY ASSURANCE

- A. Materials and application of pipe hangers and supports shall be in accordance with MSS-SP-58 and SP-69 unless noted otherwise.
- B. Support and sleeve materials and installation shall not interfere with the proper functioning of equipment.
- C. Contractor shall be responsible for structural integrity of all hangers, supports, anchors, guides, inserts and sleeves. All structural hanging materials shall have a minimum safety factor of five.

- D. Installer Qualifications: Utilize an installer experienced in performing Work of this Section who is experienced in installation of Work similar to that required for this Project and per the minimum requirements of MSS SP-89. Field welding of supports shall be by certified welders qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX using welding procedures per the minimum requirements of MSS SP-58.

#### 1.4 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog data including code compliance, load capacity, and intended application.
- B. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.
- C. Shop Drawings: Submit detailed Drawings of all shop or field fabricated supports, anchors and sleeves, signed and sealed by a qualified State of New York registered professional engineer. Indicate size and characteristics of components and fabrication details and all loads exceeding 750 pounds imposed on the base building structure.

#### 1.5 Delivery, Storage and Handling

- A. Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Maintain in place until installation.
- C. Store materials protected from exposure to harmful weather conditions.

### PART 2 PRODUCTS

#### 2.1 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

#### 2.2 MANUFACTURERS

- A. Hangers and Supports:
  - 1. Anvil International.
  - 2. Kinder.
  - 3. Cooper B-Line.
  - 4. C & S Mfg. Corp.

5. Hubbard Enterprises/Holdrite.
6. National Pipe Hanger Corporation.
7. Power Strut.

## 2.3 HANGERS AND SUPPORTS

### A. General:

1. Refer to individual system and equipment Specification Sections for additional support requirements. Comply with MSS SP-69 for support selections and applications that are not addressed within these Specifications.
2. Utilize hangers and supports to support systems under all conditions of operation, allowing free expansion and contraction, and to prevent excessive stresses from being introduced into the structure, piping or connected equipment.
3. All pipe supports shall be of the type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.
4. Design hangers to impede disengagement by movement of supported pipe.
5. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping.
6. Wire or perforated strap iron will not be acceptable as hanger material.
7. Hanger rods shall be threaded on both ends, threaded one end, or continuous threaded, complete with adjusting and lock nuts.
8. Fasteners requiring explosive powder (shooting) or pneumatic-driven actuation are not acceptable.
9. Plastic anchors or plastic expansion shields will not be permitted under any circumstances.
10. Hangers and clamps supporting and contacting individual non-insulated brass or copper lines shall be copper or copper plated. Where non-insulated brass or copper lines are supported on trapeze hangers or channels, the pipes shall be isolated from these supports with approved flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp. Plastic tape is not acceptable.
11. Hangers and clamps supporting and contacting glass piping shall be in accordance with the piping manufacturer's published recommendations and shall be fully lined with minimum 1/4 inch neoprene padding. The padding material and the configuration of its installation shall be submitted for approval.
12. Hangers and clamps supporting and contacting plastic piping shall be in accordance with the piping manufacturer's published recommendations and shall be factory coated or padded to prevent damage to piping.

13. Field fabricated supports shall be constructed from ASTM A36/A36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- B. Finishes: All ferrous hangers, rods, inserts, clamps, stanchions, and brackets on piping within interior non-corrosive environments, shall be dipped in Zinc Chromate Primer before installation. Rods may be galvanized or cadmium plated after threading, in lieu of dipping zinc chromate. All hangers and supports exposed to the weather, including roofs and building crawl space areas, shall be galvanized or manufactured from materials that will not rust or corrode due to moisture.
- C. Vertical Piping:
  1. Supports for vertical riser piping in concealed areas shall utilize double bolt riser clamps, with each end having equal bearing on the building structure at each floor level.
  2. Supports for vertical riser piping at floor levels in exposed areas shall be attached to the underside of the penetrated structure utilizing drilled anchors, two hanger rods (sized as specified), and socket clamp with washers.
  3. Two-hole rigid pipe clamps or four-hole socket clamps with washers may be used to support pipe directly from adequate structural members where floor-to-floor distance exceeds required vertical support spacing and lines are not subject to expansion and contraction.
- D. Trapezes: Where multiple lines are run horizontally at the same elevation and grade, they may be supported on manufactured channel, suspended on rods or pipes.  
Trapeze members including suspension rods shall be properly sized for the quantity, diameters, and loaded weight of the lines they are to support.
- E. Fixture and Equipment Service Piping:
  1. Piping at local connections to plumbing fixtures and equipment shall be supported to prevent the weight of the piping from being transmitted to fixtures and equipment.
  2. Makeshift, field-devised methods of plumbing pipe support, such as with the use of scrap framing materials, are not allowed. Support and positioning of piping shall be by means of engineered methods that comply with IAPMO PS 42-96. These shall be Hubbard Enterprises/Holdrite support systems, C & S Mfg. Corp. or approved equivalent.
  3. Supports within chases and partitions shall be corrosion resistant metal plate, clamps, angles or channels, and aligned with structure in the vertical or horizontal position. Plastic supports are not allowed without written approval.
  4. Horizontal supports within chases and partitions that are attached to studs shall be attached at both ends. Drywall shall not be relied upon to support the piping.
  5. Supports for plumbing fixture water service piping within chases and partitions may be attached to cast iron drain and vent pipe with approved brackets and pipe clamps.

6. Piping exposed on the face of drywall shall be supported with corrosion resistant metal channels that are attached to wall studs. Drywall shall not be relied upon to support the piping.
  7. Piping supported from the floor shall utilize corrosion resistant metal channels or brackets that are anchored to the floor slab.
  8. All water piping shall be isolated from building components to prevent the transmission of sound.
  9. All copper or brass lines shall be isolated from ferrous metals with dielectric materials to prevent electrolytic action. Plastic tape is not an acceptable isolation material.
- F. Inserts:
1. Cast-in-place concrete inserts shall comply with MSS-SP-69, U.L. and F.M. approved, and sized to suit threaded hanger rods.
  2. Inserts shall have malleable iron case with galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods. Suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction. If the inserts are later found not to be in the proper location for the placement of hangers, then drilled anchors shall be installed. Drilled anchors in concrete or masonry shall be submitted for the approval.
  3. Manufactured inserts for metal deck construction shall have legs custom fit to rest in form valleys.
  4. Shop fabricated inserts shall be submitted and approved by Owner prior to installation.
  5. Inserts shall be of a type that will not interfere with structural reinforcing and that will not displace excessive amounts of structural concrete.
- G. Pipe Shields: Provide pipe shields in accordance with insulation manufacturer's published recommendations. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier.
- H. Housekeeping Pads:
1. Provide minimum 4 inch reinforced concrete pads with chamfered corners and equipment bases for all outdoor equipment on grade, floor mounted equipment in main central plant area, mechanical rooms, areas with floors below grade, penthouse equipment rooms, floor mounted air handling units, and where shown on Drawings.
  2. Housekeeping pads shall extend minimum of 4 inch on all sides beyond the limits of the mounted equipment unless otherwise noted.

3. Provide galvanized anchor bolts for all equipment placed on concrete pads or on concrete slabs of the size and number recommended by the equipment manufacturer.

## 2.4 through penetrations

### A. General:

1. Seal penetrations through all rated partitions, walls and floors with U.L. tested assemblies to provide and maintain a rating equal to or greater than the partition, wall or floor.
2. Inside diameter of all sleeves or cored holes shall provide sufficient annular space between outside diameter of pipe or insulation to allow proper installation of required fire and water proofing materials and allow for movement due to expansion and contraction.
3. Exposed ceiling, floor and wall pipe penetrations within finished areas (including exterior wall faces) shall be provided with chrome plated, brass or stamped steel, hinged, split-ring escutcheon with set screw or snap-on type. Inside diameter shall closely fit pipe outside diameter or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings. In exterior, damp, or corrosive environments, use Type 302 stainless steel escutcheons.

### B. Floor Pipe Penetrations:

1. Seal penetrations through all floors to provide and maintain a watertight installation.
2. Sleeves cast in the slab for pipe penetrations shall be Schedule 40 steel, ASTM A53, with 2 inch wide annular fin water-stop continuously welded at midpoint. Entire assembly shall be hot-dipped galvanized after fabrication. Water-stop shall be same thickness as sleeve.
3. Cored holes in the slab for pipe penetrations shall be provided with a Schedule 40 steel, ASTM A53, sleeve with 2 inch wide annular fin water-stop continuously welded at point on sleeve to allow countersinking into slab and waterproofing. Entire sleeve assembly shall be hot-dipped galvanized after fabrication. Water-stop shall be same thickness as sleeve.
4. All sleeves shall extend a minimum of two inches above finished floor.
5. Where job conditions prevent the use of a sleeve that extends two inches above the slab, Link-Seal mechanical casing seals manufactured by Thunderline Corporation may be installed to provide a watertight penetration. Mechanical casing seals can be used only for relatively small diameter pipe penetrations. Verify that slab thickness allows proper installation of the link-seal assembly and the required fire stopping prior to applying this exception.

### C. Wall Penetrations:

1. Where piping passes through non-rated partition, close off space between pipe and construction with gypsum wallboard and repair plaster smoothed and finished to match adjacent wall area.
  2. Pipe penetrations through interior rated partitions shall be provided with adjustable prefabricated U.L. listed fire rated galvanized sheet metal sleeves having gauge thickness as required by wall fire rating, 20 gauge minimum. EXCEPTION: When U.L. Listed assembly does not require a sleeve,
  3. Pipe penetrations through exterior walls and walls below grade shall be provided with "Link-Seal" mechanical casing seal manufactured by Thunderline Corporation.
- D. Flashing:
1. Coordinate flashing material and installation required for pipe roof penetrations with Owner and roofing Contractor.
  2. Provide acoustical flashing around pipes penetrating equipment rooms, with materials and installation in accordance with manufacturer's instructions for sound control.

### PART 3 EXECUTION

#### 3.1 Preparation

- A. Conduct a pre-installation meeting prior to commencing Work of this Section to verify Project requirements, coordinate with other trades, establish condition and completeness of substrate, review manufacturer's installation instructions and manufacturer's warranty requirements.

#### 3.2 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. Application, sizing and installation of piping, supports, anchors and sleeves shall be in accordance with manufacturer's printed installation instructions.
- C. Provide for vertical adjustments after erection and during commissioning, where feasible, to ensure pipe is at design elevation and slope.
- D. Install hangers and supports to allow controlled thermal movement of piping systems, permitting freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- E. Install hanger so that rod is vertical under operating conditions.

- F. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.
- G. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete that holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required. Contractor shall be responsible for engaging a structural engineer as required for design and review at support systems.
- H. Do not hang pipe or any item directly from a metal deck or locate on the bottom chord of any truss or joist unless approved by the Structural Engineer of Record.
- I. All supports shall be designed and installed to avoid interference with other piping, hangers, ducts, electrical conduit, supports, building structures, equipment, etc.
- J. Piping supports shall be independent from other supports. Combining supports is not permitted.
- K. Provide all supporting steel required for the installation of plumbing equipment and materials, including angles, channels, beams, etc. to suspended or floor supported tanks and equipment. All of this steel may not be specifically indicated on the Drawings.
- L. Piping supports shall be designed and installed to allow the insulation to be continuous through the hangers.
- M. Adjustable clevis hangers shall be supported at rods with a nut above and below the hanger.
- N. All hanger rods shall be trimmed neatly so that 1 inch of excess hanger rod protrudes beyond the hanger nut. In the event a rod is intentionally but temporarily left excessively long (for sloped or insulated lines for example), the Contractor shall take appropriate measures to protect the pipe or other materials from damage.
- O. Install hangers to provide minimum ½ inch space between finished covering and adjacent structures, materials, etc.
- P. Horizontal and vertical piping in chases and partitions shall be supported to prevent movement and isolated from the supports to prevent transmission of sound.
- Q. Locate hangers within 12 inches of each horizontal elbow.
- R. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- S. Support riser piping independently of connected horizontal piping. Riser piping is defined as vertical piping extending through more than one floor level.



- T. Support riser piping at each floor level and provide additional supports where floor-to-floor distance exceeds required vertical support spacing. Installation of riser clamps and welded steel riser supports shall not allow weight of piping to be transmitted to floor sleeves.
- U. Steel Bar Joists: Hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded or otherwise permanently fixed to the top of joists.
- V. Steel Beams: Where pipes and loads are supported under steel beams, approved type beam clamps shall be used.
- W. 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.
- X. Flashing:
  - 1. Coordinate all roof flashing with requirements of Division 07.
- Y. Pipe Shields:
  - 1. Provide shields at each hanger supporting insulated pipe.
  - 2. Provide shields of the proper length to distribute weight evenly and to prevent compression of insulation at hanger.
  - 3. Install shield so that hanger is located at the center of the shield.
  - 4. Attach shield to insulation with adhesive to prevent slippage or movement.
- Z. Equipment Anchor Bolts:
  - 1. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt shall be set in a sleeve of sufficient size to provide ½ inch clearance around bolt.

END OF SECTION

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## SECTION 220553 - PLUMBING IDENTIFICATION

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Pipe labels.
  - 3. Valve tags.

#### 1.2 ACTION SUBMITTALS

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

#### 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, 1/8 inch thick, and having predrilled holes for attachment hardware.
  - 2. Letter Color: White
  - 3. Background Color: Black
  - 4. Maximum Temperature: Able to withstand temperatures up to 180 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-quarters the size of principal lettering.
  - 7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

1. WARNING SIGNS AND LABELS

D. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

E. Letter Color: White

F. Background Color: Red

G. Maximum Temperature: Able to withstand temperatures up to 180 deg F.

H. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

I. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

J. Fasteners: Stainless-steel rivets or self-tapping screws.

K. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

L. Label Content: Include caution and warning information plus emergency notification instructions.

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.

## 2.3 VALVE TAGS

- A. Valve Tags: 1-1/2 inch diameter, stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
  - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass wire-link or beaded chain; or S-hook.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1. Valve-tag schedule shall be included in operation and maintenance data.

## 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 PIPE LABEL INSTALLATION

- A. 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.

### 3.3 VALVE TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

END OF SECTION

## SECTION 220719 - PIPING INSULATION

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Perform all Work required to provide and install piping insulation, jackets and accessories indicated by the Contract Documents with supplementary items necessary for proper installation.
- B. Section includes insulating the following plumbing piping services:
  - 1. Domestic cold-water piping.
  - 2. Domestic hot-water piping.
  - 3. Domestic re-circulating hot-water piping.
  - 4. Roof drains and rainwater leaders.
    - a. ACTION SUBMITTALS
- C. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
  - a. QUALITY ASSURANCE
- D. 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.
- E. 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.
    - a. DELIVERY, STORAGE, AND HANDLING
- F. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

### PART 2 PRODUCTS

#### 2.1 Preformed FiberGlass Pipe Insulation:

- A. Products: Subject to compliance with requirements, provide one of the following:
  - 1. [Johns Manville; Micro-Lok](#) HP.
  - 2. [Knauf Insulation; 1000-Degree Pipe Insulation](#).
  - 3. [Owens Corning; Fiberglas Pipe Insulation](#).
- B. All piping shall be insulated with a preformed fiberglass pipe insulation, complying with ASTM C 547, Class 3 (to 850°F), rigid, molded pipe insulation, noncombustible.
  - 1. Thermal Conductivity ("k"): 0.23 Btu•in/(hr•ft<sup>2</sup>•°F) at 75°F mean temperature per ASTM C 518.
  - 2. Maximum Service Temperature: 850°F.
  - 3. Rated 25/50 per ASTM E 84, UL 723 and NFPA 255.
  - 4. When being used over stainless steel, product must comply with the requirements of ASTM C 795.
  - 5. All-Service (ASJ) Vapor-Retarder Jacket: A white, kraft paper, reinforced with a glass fiber yarn and bonded to an aluminum foil, with self-sealing longitudinal closure laps (SSL) and butt strips.

## 2.2 FITTING INSULATION

- A. Fiberglass Insulation System:
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. [Johns Manville](#); Zeston.
    - b. [Proto Corporation](#); LoSmoke.
    - c. [Speedline Corporation](#); SmokeSafe.
  - 2. Pre-molded fitting insulation: Same thickness as the adjacent pipe covering.
    - a. Conform to FS-HH-I-558C, Form E, Class 16.
  - 3. PVC/Fiberglass Fitting Insulation: Polyvinyl chloride pre-molded flexible fitting cover with batt type, pre-cut fiberglass insert.
    - a. PVC: Conform with FS L-P-535C, Composition A, Type II, Grade GU.
    - b. Fiberglass: Conform with FS HH-I-558C, Form B, Type I, Class 7&8.
    - c. FIELD-APPLIED JACKETS
      - 1) PVC Jacket: 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.
        - a) Products: Subject to compliance with requirements, provide products by one of the following:
          - 1 [Johns Manville; a Berkshire Hathaway company](#).
          - 2 [Proto Corporation](#).
          - 3 [Speedline Corporation](#).
        - b) Adhesive: As recommended by jacket material manufacturer.
        - c) Color: White.



- d) Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
  - 1 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.
- d. MASTICS
- B. 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).
- C. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
  - 1. Products: Subject to compliance with requirements, [provide the following] [provide one of the following] [available products that may be incorporated into the Work include, but are not limited to, the following]:
    - a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
    - b. Vimasco Corporation; 749.
  - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  - 5. Color: White.
    - a. PROTECTIVE SHIELDING GUARDS
      - 1) Protective Shielding Pipe Covers:
        - a) Description: Manufactured plastic wraps for covering plumbing fixture hot and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

### 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. Do not install insulation until the piping has been tested and accepted.
- B. Clean and dry all piping to be insulated prior to applying insulation.

### 3.3 INSTALLATION, GENERAL

- A. Comply with the manufacturer's printed installation instructions, except as specified otherwise.
  - a. PENETRATIONS
- B. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
  - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- E. Insulation Installation at Floor Penetrations:
  - 1. Pipe: Install insulation continuously through floor penetrations.
  - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."
    - a. INSTALLATION OF fiberglass INSULATION
- F. Insulation on all cold surfaces must be applied with a continuous, unbroken vapor seal. Hangers, supports, anchors, etc., that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation.
- G. For chilled water piping systems, seal pipe terminations every four pipe sections.
- H. Preformed fiber glass pipe insulation with all-service jacket shall be applied to piping with all joints tightly fitted to eliminate voids.
- I. Longitudinal jacket laps and butt strips shall be smoothly secured according to manufacturer's recommendations.
- J. When adhered, the lap and butt strips must be pressurized by rubbing firmly with a plastic squeegee or the back of a knife blade to ensure positive closure.

- K. PVC/Fiberglass Fitting Insulation: Tuck the ends of the pre-cut insulation batt snugly into the throat of the fitting, tuft and tuck-in the edges adjacent to the pipe insulation. Install fitting cover and seal as follows:
1. Hot Service Insulation: Secure the cover with staples, thumb tack fasteners, or sealing tape.
  2. Cold Service Insulation: Seal ends of each section of insulation and apply a coating of vapor barrier mastic at each joint and seam to maintain a continuous vapor barrier.

### 3.4 INSTALLATION AT HANGERS

- A. Reset and realign hangers and supports if they are displaced while installing the piping insulation.
- B. Fiberglass Insulation: Install high density insulation filler pieces, at all points of support, between pipe insulation shields and pipe or tubing not supported by an insulation shield and insulating saddle unit. Do not install high density insulation filler pieces on hot service piping 6" and larger scheduled to have steel saddles. Install filler pieces of the same thicknesses as adjoining pipe insulation x 12" length.
1. Install high density molded polyurethane or high-density polystyrene filler pieces.
- C. Galvanized metal shields shall be applied between hangers or supports and the pipe insulation. Shields shall be formed to fit the insulation and shall extend up to the centerline of the pipe and 8" length.

#### a. INDOOR PIPING INSULATION SCHEDULE

| SERVICE  | TYPE       | THICKNESS | COMMENTS              |
|--|------------|-----------|-----------------------|
| DOMESTIC COLD-WATER PIPING 1" AND SMALLER              | FIBERGLASS | 0.5       |                       |
| DOMESTIC COLD-WATER PIPING 1-1/4" AND LARGER           | FIBERGLASS | 1.0       |                       |
| DOMESTIC HOT WATER AND RECIRC PIPING 1" AND SMALLER    | FIBERGLASS | 1.0       |                       |
| DOMESTIC HOT WATER AND RECIRC PIPING 1-1/4" AND LARGER | FIBERGLASS | 1.5       |                       |
| STORM DRAIN PIPING                                     | FIBERGLASS | 1.0       |                       |
| ROOF DRAIN BODIES                                      | FIBERGLASS | 1.0       | ARMAFLEX MAY BE USED. |

|  |            |     |  |
|--|------------|-----|--|
| EXPOSED PIPING AND<br>STOPS FOR PLUMBING<br>FIXTURES FOR PEOPLE<br>WITH DISABILITIES | FIBERGLASS | 1.0 | PROVIDE PROTECTIVE<br>SHIELDING PIPE<br>COVERS |
|--|------------|-----|--|

ALL EXPOSED PIPING SHALL HAVE PVC JACKETING

END OF SECTION

## SECTION 221000 - PLUMBING PIPING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Provide materials and installation for complete plumbing systems, within and to five feet beyond building perimeter unless noted otherwise on Contract Drawings; Sanitary Waste and Vent Piping, Storm Drain Piping, Domestic Water Piping, Domestic Water Valves, Testing and other normal parts that make the systems operable, code compliant and acceptable to the authorities having jurisdiction.

#### 1.2 REFERENCE STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
  - 1. New York State Plumbing Code.
  - 2. ANSI/NSF Standard 61 - Drinking Water System Components - Health Effects.
  - 3. ANSI/NSF Standard 372 – Lead Content in domestic water systems

#### 1.3 QUALITY ASSURANCE

- A. Manufacturer's name and pressure rating shall be permanently marked on valve body.
- B. The Contractor shall notify the manufacturer's representative prior to installing any copper press fittings. The Contractor shall obtain the representative's guidance in any unfamiliar installation procedures. The manufacturer's representative of copper press fittings shall conduct periodic inspections of the installation and shall report in writing to the Contractor and Owner of any observed deviations from manufacturer's recommended installation practices.
- C. Manufacturer Qualifications: Company shall have minimum three years documented experience specializing in manufacturing the products specified in this section.
- D. Installer Qualifications:
  - 1. Company shall have minimum three years documented experience specializing in performing the work of this section.

2. All installers of copper press fittings shall be trained by the fitting manufacturer's appointed representative. Written notification of training shall be submitted to Owner prior to any installation.
- E. Special Engineered products shall be certified by NSF International as complying with NSF 14.

#### 1.4 SUBMITTALS

- A. Product Data:
  1. Code and Standards compliance, manufacturer's data for pipe, fittings, valves and all other products included within this specification section.
  2. Manufacturer's installation instructions.
- B. Record Documents:
  1. Record actual locations of valves, etc. and prepare valve charts.
  2. Test reports and inspection certification for all systems listed herein.
  3. Provide a certificate of completion detailing the domestic water system chlorination procedure.
  4. Submit proposed location of access panels which vary from quantities or locations indicated on Contract Drawings.
- C. Operation and Maintenance Data:
  1. Include components of system, servicing requirements, Record Drawings, inspection data, installation instructions, exploded assembly views, replacement part numbers and availability, location and contact numbers for service.

#### 1.5 DELIVERY, STORAGE and HANDLING

- A. All materials shall be new, undamaged, and free of rust.
- B. Accept valves on Site in shipping containers and maintain in place until installation.
- C. Provide temporary protective coating and end plugs on valves not packaged within containers. Maintain in place until installation.
- D. Provide temporary end caps and closures on pipe and fittings. Maintain in place until installation.
- E. Protect installed piping, valves and associated materials during progression of the construction period to avoid clogging with dirt, and debris and to prevent damage, rust, etc. Remove dirt and debris and repair materials as work progresses and isolate parts of completed system from uncompleted parts.
- F. Protect all materials that are to be installed within this project from exposure to rain, freezing temperatures and direct sunlight. EXCEPTION: Materials manufactured for exterior locations.

## PART 2 PRODUCTS

### 2.1 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
- B. Provide materials as specified herein and indicated on Contract Drawings. All materials and work shall meet or exceed all applicable Federal and State requirements and conform to adopted codes and ordinances of authorities having jurisdiction.
- C. Pressure ratings of pipe, fittings, couplings, valves, and all other appurtenances shall be suitable for the anticipated system pressures in which they are installed.
- D. All materials within domestic water distribution systems that may come in contact with potable water delivered shall comply with ANSI/NSF standard 61.

### 2.2 SANITARY WASTE AND VENT AND STORM DRAINAGE PIPING

- A. BELOW GRADE SANITARY WASTE AND VENT PIPING
  - 1. Hub-and-Spigot, Cast-Iron Soil Pipe and Fittings.
    - a. Pipe and Fittings: ASTM A 74, Service Weight.
    - b. Gaskets: ASTM C 564, rubber.
- B. ABOVE GRADE SANITARY WASTE AND VENT PIPING
  - 1. Hubless, Cast-Iron Soil Pipe and Fittings.
    - a. Pipe and Fittings: ASTM A 888 or CISPI 301.
    - b. CISPI, Hubless-Piping Couplings:
    - c. Standards: ASTM C 1277 and CISPI 310.
    - d. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- C. Pipe and fittings shall be manufactured as a system and be the product of one manufacturer.
- D. All pipe and fittings shall be manufactured in the United States. All systems shall utilize a separate waste and vent system. Pipe and fittings shall conform to National Sanitation Foundation Standard 14.
- E. All P-traps for floor drains, floor sinks and hub drains shall be deep-seal type.

### 2.3 DOMESTIC WATER PIPING

A. COPPER TUBE AND FITTINGS

1. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
2. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
3. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
4. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
5. Copper Unions:
  - a. MSS SP-123.
  - b. Cast-copper-alloy, hexagonal-stock body.
  - c. Ball-and-socket, metal-to-metal seating surfaces.
  - d. Solder-joint or threaded ends.
6. Copper, Brass, or Bronze Pressure-Seal-Joint Fittings:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Nibco
    - 2) Elkhart
    - 3) Viega
  - b. Fittings: Cast-brass, cast-bronze or wrought-copper with EPDM O-ring seal in each end. Sizes NPS 2-1/2 and larger with stainless steel grip ring and EPDM O-ring seal.
  - c. Minimum 200-psig working-pressure rating at 250 deg F.
  - d. All copper press fittings, couplings and specialties shall be the products of a single manufacturer. Installation tools shall be as recommended by the fittings manufacturer.
7. Appurtenances for Grooved-End Copper Tubing:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Victaulic
    - 2) Anvil
  - b. Bronze Fittings for Grooved-End, Copper Tubing: ASTM B 75/B 75M copper tube or ASTM B 584 bronze castings.
  - c. Mechanical Couplings for Grooved-End Copper Tubing:
    - 1) Copper-tube dimensions and design similar to AWWA C606.
    - 2) Ferrous housing sections.
    - 3) EPDM-rubber gaskets suitable for hot and cold water.
    - 4) Bolts and nuts.
    - 5) Minimum Pressure Rating: 300 psig.

B. PIPING SCHEDULE

1. Aboveground domestic water piping, NPS 2 and smaller shall be one of the following:



- a. Hard copper tube, ASTM B 88, Type L; cast or wrought copper, solder-joint fittings; and soldered joints.
    - b. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
  2. Aboveground domestic water piping, NPS 2-1/2 to NPS 8, shall be one of the following:
    - a. Hard copper tube, ASTM B 88, Type L; cast or wrought copper, solder-joint fittings; and soldered joints.
    - b. Hard copper tube, ASTM B 88, Type L; grooved-joint, copper-tube appurtenances; and grooved joints.
  3. Underground water-service piping NPS 3/4 to NPS 3 shall be the following:
    - a. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A) wrought-copper, solder-joint fittings; and brazed joints.
- C. All materials within domestic water distribution systems that may come in contact with the potable water delivered shall comply with ANSI/NSF Standard 61 and NSF 372.
- D. All brass and bronze piping materials within domestic water distribution systems that may come in contact with the potable water delivered shall have no more than 15% zinc content. Valves may have above 15% zinc if they pass ISO 6509 Testing
- E. Solder for copper piping shall be lead-free Tin/Copper/Silver/Nickle(optional) solder conforming to ASTM B32, Wolverine Silvabrite 100 Lead-Free Solder or Harris Nick Lead-Free Solder. Use water soluble flux recommended by solder manufacturer and conforming to ASTM B813 NSF 61, and NSF 372 Wolverine Silvabrite 100 Water Soluable Flux or Bridgit Water Soluble Paste Flux.
- F. Dielectric waterway fittings shall have zinc electroplated steel pipe body with high temperature stabilized polyolefin polymer liner; manufactured by Victaulic, Style 647 or PPP, Inc. Series 19000.
- G. Dielectric unions shall be lead free rated at 250 psi, ground-joint type with inert, non-corrosive thermoplastic sleeve. End connection materials shall be compatible with respective piping materials; manufactured by EPCO Sales, Inc or Watts. Provide models to suit applicable transitions.
- H. Dielectric flanges shall be rated at 175 psi, have nylon bolt isolators and dielectric gasket. Materials shall be compatible with respective piping materials; manufactured by EPCO Sales, Inc or Watts. Provide models to suit applicable transitions.
- I. Pipe joint compound shall be lead-free, non-toxic, non-hardening and compliant with ANSI/NSF 61 & 372 and Federal Specification TT-S-1732. Temperature service range of -15°F to +400°F, manufactured by Hercules "MegaLoc" or approved equal by Rectorseal, La-Co or Oatey.

## 2.4 DOMESTIC WATER VALVES:

- A. All materials within domestic water distribution systems that may come in contact with the potable water delivered shall comply with ANSI/NSF Standard 61 and NSF 372.
- B. All brass and bronze valve materials within domestic water distribution systems that may come in contact with the potable water delivered shall have no more than 15% zinc content.
- C. Similar types of valves shall be the product of one manufacturer; i.e., all butterfly valves shall be of the same manufacturer, all ball valves shall be of the same manufacturer, etc. EXCEPTION: 2-1/2" & 3" ball valves may be by a different manufacturer than 2" and smaller ball valves.
- D. Line Shut-Off Valves up to and including 2" shall be two-piece bronze body of ASTM B584 Alloy 844, ASTM B61, or ASTM B62, full port ball type rated at 600 WOG with threaded connections, blow-out proof stem, plastic coated lockable lever handle, Teflon packing, 316 stainless steel ball and stem. Acceptable valves are NIBCO Model T-585-66-LF, or approved equivalent model by Crane, Milwaukee or Apollo.
- E. Line Shut-Off Valves sizes 2-1/2" and 3" shall be full port ball type rated at 400 WOG with threaded connections, two-piece bronze body ASTM B584 with 316 stainless steel ball and stem, plastic coated lockable lever handle, blow out proof stem and reinforced Teflon seats. Acceptable valves are Kitz Model 68PM, or approved equivalent model by Crane, NIBCO, Milwaukee or Apollo.
- F. Line Shut-Off Valves sizes 4" and larger shall be ductile iron butterfly type rated at 200 WOG with lug pattern connection, stainless steel disc and stem, lockable lever handle, EPDM seal. Acceptable valves are Milwaukee Model M-234ES, or approved equivalent model by Crane, NIBCO or Apollo.
  - 1. Grooved end Valves: Butterfly Valves: 2-1/2" - 6", 300 psi maximum pressure rating, with copper tubing sized grooved ends. Cast brass body to UNS C87850. Aluminum bronze disc to UNS C95500, with pressure responsive elastomer seat. Stem shall be offset from the disc centerline to provide complete 360-degree circumferential seating. Bubble tight, dead-end or bi-directional service, with memory stop for throttling, metering or balancing service. Valve may be automated with electric, pneumatic, or hydraulic operators. Certified to the low lead requirements of NSF-372. Victaulic Series 608N.
- G. Provide stem extensions of a non-thermal conducting material for valves in insulated lines to allow unobstructed operation.
- H. Provide memory stops on all ball valves installed in domestic hot water return lines. Memory stops shall be adjustable after pipe insulation is applied.
- I. Provide line shut-off valves that have the same inside diameter of the upstream pipe in which they are installed.

- J. Domestic Hot Water Return Circuit Balancing Valves 1/2" through 2" shall be 'Y or T' pattern with threaded inlet and outlet connections, equal percentage globe-style and provide precise flow measurement, precision flow balancing and positive drip-tight shut-off. Valves shall provide multi-turn, 360° adjustment with micrometer type indicators located on the valve handwheel. Valves shall have a minimum of five full 360° handwheel turns. 90° 'circuit-setter' style ball valves are not acceptable. Valve handle shall have hidden memory feature to provide a means for locking the valve position after the system is balanced. Valves shall be furnished with precision machined venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The venturi shall have two, 1/4" threaded brass metering ports with check valves and gasketed caps located on the inlet side of the valve. Valves shall be furnished with flow smoothing fins downstream of the valve seat and integral to the forged valve body to make the flow more laminar. The valve body, stem and plug shall be brass. The handwheel shall be high-strength resin. Provide valves as scheduled on Contract Drawings manufactured by Armstrong Model CBV-VT or NIBCO T-1710 and F737-A. Furnish each valve complete with optional pre-formed 25/50 fire/smoke rated insulation.
- K. Domestic Hot Water Return Circuit Balancing Valves Designed specifically for use in drinking water applications, NSF/ANSI 61 rated for commercial hot water service (temperature rated to 180F), and certified by the NSF with all wetted parts stainless steel; lead-free construction in compliance with ANS/NSF-372; Series 300 stainless steel body, nickel plated brass union nut, and tamper-resistant flow cartridge 300 series stainless steel. Valve shall be suitable for maximum flow of 12 gallons per minute, and flow rate pre-set accuracy variation of +/-5% over 95% of the control range. Valves shall have a full body rating of 400 psi but is suitable for working pressures with differential control ranges of 2 - 32 psi or 5 - 60 psi differential. Compact in-line design for tight installations. Basis of Design Victaulic 76X
- L. Domestic Hot Water Return Thermostatic Balancing Valves 1/2" through 2" shall be self-contained and fully automatic without additional piping or control mechanisms. Thermostatic Balancing Valves shall regulate the flow of recirculated domestic hot water based on water temperature entering the valve regardless of system operating pressure. When fully closed the valve shall bypass a minimum flow to maintain dynamic control of the recirculating loop and provide a means for system sanitizing. The valve shall be field adjustable from 105F to 180F as required by project conditions. The valve shall modulate between open and closed position within a 10F range. Valve bodies and all internal components shall be constructed of stainless steel or lead-free brass. Provide suitable line sized ball valves, unions, and access panels as required in non-accessible ceilings and walls.
- M. Swing Check Valves, 2" and smaller - "Y" or "T" pattern lead free bronze, Class 150, with threaded connections and screw-in cap. Manufactured by NIBCO Model T-413-Y-LF or approved equivalent model by Milwaukee or Crane.

- N. Spring Loaded Check Valves, 2" and smaller - Silent closing, lead free bronze, Class 125, with threaded connections, Buna disc, bronze or stainless-steel spring. Manufactured by NIBCO Model T-480-Y-LF or approved equivalent model by Milwaukee or Crane.

### PART 3 EXECUTION

#### 3.1 Examination

- A. Before commencing work, check final grade and pipe invert elevations required for drain terminations and connections to ensure proper slope.

#### 3.2 PREPARATION

- A. Ream pipes and tubes. Remove burrs, scale and dirt, inside and outside, before assembly. Remove foreign material from piping.
- B. Prepare piping connections to equipment with flanges or unions.

#### 3.3 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations.
- C. General
  - 1. Care shall be exercised to avoid all cross connections and to construct the plumbing systems in a manner which eliminates the possibility of water contamination.
  - 2. Install all materials and products in accordance with manufacturer's published recommendations. Use tools manufactured for the installation of the specific material or product.
  - 3. Wipe all paste residue and excess solder from all solder joints.
  - 4. Heat generated by soldering procedures shall not be transmitted to valves, copper alloy roll groove fittings, copper press fittings, no-hub clamps, or any other components installed within the piping system that may be damaged due to high temperatures. Contractor shall take all precautions necessary, including utilizing wet wrapping or allowing heated piping to cool to ambient temperature before attachment.
  - 5. Pipe joints, flanges, unions, etc., shall not directly contact or be encased in concrete, or be located within wall, floor or roof penetrations.

6. Grooved Joints: Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. The gasket style and elastomeric material shall be verified as suitable for the intended service as specified. Flexible couplings only to be used for expansion loops, pump trim and where approved by the engineer. A factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. All groove depths shall be checked manually or by grooving tool (RG5200i). A Victaulic representative shall periodically visit the job site and review installation.
7. Route piping in direct orderly manner and maintain proper grades. Installation shall conserve headroom and interfere as little as possible with use of spaces. Route exposed piping parallel to walls. Group piping whenever practical at common elevations.
8. Install piping to allow for expansion and Contraction without stressing pipe, joints or connected equipment.
9. Furnish all supports required by the piping included in this specification section.
10. Penetrations through fire rated walls, floors and partitions shall be sealed to provide a U.L. rating equal to or greater than the wall, floor or partition.
11. Seal all penetrations through floors, air and water tight.
12. Each plumbing pipe projecting through roof shall be installed in accordance with Contract Specifications and Drawings. Penetrations shall be sealed air and water tight. Refer to details on Contract Drawings and coordinate with General Contractor for flashing requirements.
13. Furnish and install all necessary valves, traps, gauges, strainers, unions, etc. for each piece of equipment (including Owner furnished equipment) having plumbing connections, to facilitate proper functioning, servicing and compliance with code.
14. Provide code-approved transition adapters when joining dissimilar piping materials. Adaptors installed shall be manufactured specifically for the particular transition.
15. All piping shall have reducing fittings used for reducing or increasing where any change in the pipe sizes occurs. No bushing of any nature shall be allowed in piping.
16. Close nipples shall not be installed in plumbing piping systems.
17. Buried piping shall be supported throughout its entire length.
18. All excavation required for plumbing work is the responsibility of the plumbing Contractor and shall be done in accordance with Contract Documents.
19. Piping shall be insulated in accordance with Contract Documents.
20. Provide clearance for installation of insulation and for access to valves, air vents, drains, unions, etc.
21. Provide dielectric isolation device where non-ferrous components connect to ferrous components. Devices shall be dielectric union, coupling or dielectric flange fitting.

22. All piping shall be isolated from building structures, including partition studs, to prevent transmission of vibration and noise.
23. Isolate all bare copper pipe from ferrous building materials. Tape is not an acceptable isolator.

D. Drainage and Vent Systems

1. Installation shall comply with the latest installation instructions published by the manufacturer and shall conform to all local plumbing, building, and fire code requirements.
2. Systems shall be hydrostatically tested after installation.
3. Slope drainage lines uniformly at 1/4" per foot, for lines 3" and less, and 1/8" per foot for larger lines, unless noted otherwise on Contract Drawings. Maintain gradients through each joint of pipe and throughout system.
4. Buried pipe shall be laid on a smoothly graded, prepared subgrade soil foundation true to alignment and uniformly graded. Bell holes shall be hand-excavated so that the bottom of the pipe is in continuous contact with the surface of the prepared subgrade material. Piping invert shall form a true and straight line.
5. The size of drainage piping shall not be reduced in size in the direction of flow. Drainage and vent piping shall conform to the sizes indicated on the Contract Drawings. Waste lines from water closets shall not be smaller than four inches. Under no circumstances shall any drain or vent line below slab be smaller than two inches.
6. Unburied horizontal drain piping shall be supported at least at every other joint except that when the developed length between supports exceeds four feet, they shall be provided at each joint. Supports shall also be provided at each horizontal branch connection and at the base of each vertical rise. Supports shall be placed immediately adjacent to the joint. Suspended lines shall be braced to prevent horizontal movement. Unburied vertical drain piping rising through more than one floor level shall be supported with riser clamps at each floor level.
7. All unburied change of direction fittings within the storm drainage system shall be braced against thrust loads that might result in joint separation due to dynamic forces caused by sudden, heavy rainfall conditions. Bracing shall incorporate galvanized steel pipe clamps and tie rods.
8. Provide cleanouts within sanitary waste systems at locations and with clearances as required by the code, at the base of each waste stack and at intervals not exceeding 75 feet in horizontal runs.
9. Provide cleanouts at the base of each vertical downspout and at intervals not exceeding 75 feet in horizontal building storm drain. Provide clearances as required by code.
10. A removable sink or lavatory p-trap with cleanout plug shall be considered as an approved cleanout for 2" diameter pipe.

11. All interior cleanouts shall be accessible from walls or floors. Provide wall cleanouts in lieu of floor cleanouts wherever possible. A floor cleanout shall be installed only where installation of a wall cleanout is not practical.
12. Provide a wall cleanout for each water closet or battery of water closets. Locate wall cleanouts above the flood level rim of the highest water closet but no more than twenty-four inches above the finished floor.
13. Coordinate the location of all cleanouts with the architectural features of the building and obtain approval of locations from the Project Architect.
14. Lubricate cleanout plugs with anti-seize lubricant before installation. Prior to final completion, remove cleanout plugs, re-lubricate and reinstall using only enough force to provide a water and gas tight seal.
15. Install trap primer supply to floor drains, hub drains and floor sinks that are susceptible to trap seal evaporation and where indicated on Project Drawings. Primer unit installation shall comply with manufacturer's published recommendations. Trap primer lines shall slope to drain at a minimum  $\frac{1}{4}$ " per foot.
16. Capped waste and vent connections for future extensions shall be located accessibly and not extend more than 24" from active main. Waste connections and vent connections shall be located at elevations that will allow future installation of properly sloped piping without the need to dismantle or relocate installed ductwork, piping, conduit, light fixtures, etc.
17. Locate all sanitary vent terminals a minimum of 25 feet horizontally from or 3 feet vertically above all air intakes, operable windows, doors and any other building openings.
18. Wastewater when discharged into the building drainage system shall be at a temperature not higher than 140°F. When higher temperatures exist, approved cooling methods shall be provided.

E. Domestic Water System

1. On each water supply line serving a plumbing fixture, item of equipment, or other device which has a water supply discharge outlet below the overflow rim, or where cross contamination may occur, provide and install an approved vacuum breaker or backflow preventer. Installation of vacuum breakers shall prevent any possible backflow through them.
2. Copper piping shall be supported at no greater than six-foot intervals for piping 1-1/2" and smaller and ten foot intervals for piping 2" and larger in diameter.
3. Install all water piping to allow all piping within the system to be drained at low points.
4. Air chambers, dead-legs, or any other piping arrangement that may allow water to stagnate shall not be installed within domestic water systems. Valves installed for future connections shall not extend more than 24" from an active main.
5. Provide manufactured water hammer arrestors in water supply lines in accordance with Standard PDI-WH201.

6. Install union type fitting downstream of isolation valves at equipment connections.
7. Solder joint fittings shall not be installed within 24" of a copper press fitting.
8. Threaded adaptors shall be of the same manufacture and type as the system's copper fittings.
9. Threaded adaptors on supply stub-outs shall be installed prior to construction of wall and shall not extend more than 1" beyond wall face.

F. Domestic Water Valves

1. Domestic water shut-off valves shall be installed where shown on Drawings, at each fixture and piece of equipment, at each branch take-off from mains, at the base of each riser, and at each battery of fixtures.
2. Install shut-off valves in accessible locations. Provide access panels where valves would otherwise be inaccessible. Coordinate quantity, size and location requirements of access panels with General Contractor.
3. Install shut-off valves with stems upright or horizontal, not inverted.
4. Where threaded valves are installed in copper piping systems special care shall be taken to avoid damaging the valve or its parts due to overheating. Install copper or bronze male adapters in each inlet of threaded valves. Sweat solder adapters to pipe prior to connecting to valve body.
5. Provide spring loaded type check valves on discharge of water pumps.
6. Provide accessible check valves in the individual cold and hot water fixture supply lines serving mixing valve type faucets or assemblies having hose connection outlets that are not equipped with integral check stops.
7. Install a shutoff valve immediately upstream of each strainer.
8. Install domestic hot water return circuit balancing valves where indicated on Contract Drawings and locate a minimum of five pipe diameters downstream and three pipe diameters upstream of all fittings and/or line shut-off valves. Location of valves shall allow unobstructed access for monitoring and adjustment.
9. Adjust and set domestic hot water return circuit balancing valves to flows indicated on Contract Drawings and in accordance with valve manufacturer's published instructions. Use flow meter recommended by valve manufacturer.
10. Provide a temperature gauge, strainer, union and line shut-off valve upstream of each hot water return circuit balancing valve.

3.4 TESTING and cleaning

A. General

1. Equipment, material, power, and labor necessary for the cleaning, flushing, sterilization, inspection and testing of systems covered within this Specification Section shall be furnished by the Plumbing Contractor.



2. All new and parts of existing altered, extended, or repaired plumbing system piping shall be tested and inspected for leaks and defects. Piping being tested shall not leak nor show any loss in test pressure for duration specified.
3. In cases of minor installation and repairs where specified water and/or air test procedures are deemed impractical, Contractor shall obtain written approval from Owner's Representative to perform alternate testing and inspection procedures. Alternate testing and inspection procedures for minor installation and repairs shall include visual evaluation of installed components by Owner's Representative during a simulation of use.
4. The water utilized for tests shall be obtained from a potable source of supply.
5. Prepare testing reports. If testing is performed in segments, submit separate report for each segment, complete with diagram or clear description of applicable portion of piping. After inspection has been approved or portions thereof, certify in writing the time, date, name and title of the persons reviewing the test. This shall also include the description of what portion of the system has been approved. Obtain approval signature by Owner's Representative. A complete record shall be maintained of all testing that has been approved and shall be made available at the job Site. Upon completion of the work, all records and certifications approving testing requirements shall be submitted to the Owner's Representative before final payment is made.
6. Verify systems are complete, flushed and clean prior to testing. Isolate all equipment subject to damage from test pressure. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. Leave piping uninsulated, uncovered and unconcealed until it has been tested and approved. Where any portion of piping system must be concealed before completion of entire system, the portion shall be tested separately as specified for the entire system prior to concealment. Contractor shall expose all untested covered or concealed piping.
7. Gauges used for testing shall have increments as follows:
  - a. Tests requiring a pressure of 10 psi or less shall utilize a testing gauge having increments of 0.10 psi or less.
  - b. Tests requiring a pressure of greater than 10 psi but less than or equal to 100 psi shall utilize a testing gauge having increments of 1 psi or less.
  - c. Tests requiring a pressure of greater than 100 psi shall utilize a testing gauge having increments of 2 psi or less.
8. Separately test above and below ground piping.
9. Do not introduce test water into piping systems when exposure to freezing temperatures is possible.
10. Do not introduce test water into sections of piping located above existing sensitive areas and/or equipment that may be damaged or contaminated by water leakage. Coordinate with Owner's Representative to determine areas and/or equipment considered as being sensitive.

11. Defective work or material shall be reworked and replaced, and inspection and test repeated. Repairs shall be made with new materials. Pipe dope, caulking, tape, dresser couplings, etc., shall not be used to correct deficiencies.
12. The Contractor shall be responsible for cleaning up any leakage during flushing, testing, repairing and disinfecting to the original condition any building parts subjected to spills or leakage.

B. Drainage and Vent System

1. Subject gravity drainage and vent piping and joints to a vertical water column pressure of at least ten feet. If after 15 minutes the level of the water has been lowered by leakage, the leaks must be found and stopped and the water level shall again be raised to the level described and the test repeated until, after a 15 minute retention period, there shall be no perceptible lowering of the water level in the system being tested. EXCEPTION: Portions of drainage and vent piping located on uppermost level of building shall be subjected to a water column pressure created by filling the system to point of overflow at roof vent terminals and roof drains. The pipes for the level being tested shall be filled with water to a verifiable and visible level as described above and be allowed to remain so for 15 minutes.
2. Should the completion of these tests leave any reasonable question of a doubt relative to the integrity of the installation, additional tests or measures shall be performed to demonstrate the reliability of these systems to the complete satisfaction of the Owner's Representative.
3. Test plugs must extend outside the end of pipe to provide a visible indication for removal after the test has been completed.

C. Domestic Water System

1. Subject piping system to a hydrostatic pressure of at least 125 pounds per square inch gauge, but not less than the operating pressure under which it is to be used, for a period of no less than 15 minutes. During test period, all pipe, fittings and accessories in the particular piping system that is being tested shall be carefully inspected. If leaks are detected, such leaks shall be stopped and the hydrostatic test shall again be applied. This procedure shall be repeated until no leaks are detected for an entire 15 minute period. EXCEPTION: Piping located above sensitive areas and/or equipment that may be damaged or become contaminated due to test water leakage shall be tested with oil-free air in lieu of water.

2. After completion of the testing, all new and/or altered water piping systems shall be thoroughly sterilized with a solution containing not less than 50 parts per million of available chlorine. Do not exceed 150 parts per million at any time. Introduce chlorine into the supply stream at a rate sufficient to provide a uniform concentration throughout the system. All outlets shall be opened and closed several times. When the specified level of chlorine is detected at every outlet in the system, close all valves to prevent release of water from the system for 24 hours. At the completion of the 24 hour disinfection period, test every outlet for a minimum chlorine residual of fifty parts per million. This minimum residual must be present to proceed with flushing. Flush the system with clean water at a sufficient velocity until the residual chlorine detected at every outlet is within 0.2 parts per million of the normal water supply's level.
3. Sufficient samples must be taken no sooner than 24 hours after sterilization and flushing to represent the extent and complexity of the affected water system, along with a control sample to indicate municipal water quality at the time of testing. Send water samples to an accredited laboratory to perform qualitative and quantitative bacteriological analysis in accordance with AWWA C651. Contractor shall obtain written certification from the independent testing agency stating that the water samples meet Federal and State guidelines for safe drinking water. Upon satisfactory completion of all procedures, and receipt of acceptable laboratory test results, obtain written approval by Owner's representative. Failure to fully comply with the above procedures will result in a requirement to repeat the procedure until acceptable results are achieved, at no additional cost to the Owner.
4. Isolate or bypass equipment that would be detrimentally affected by disinfecting solution. Isolate all other sections of the domestic water system not being disinfected to prevent migration of chlorine.
5. Prior to injection of chlorine into the piping system, strategically place signs stating "Heavily Chlorinated Water - Do Not Drink", and protect all outlets to prevent use during disinfection and flushing procedures.
6. A bacteria test is not necessary for small scale work. However, disinfection is required. Examples of small scale work are less than 20 feet of pipe, replacement and/or installation of a sink, drinking fountain, eyewash, backflow preventer, isolation valve, etc. Disinfect individual parts, fixtures, isolation valves, pipes, etc. by swabbing with full strength bleach (5.25%) or soaking for at least 30 minutes in a 500 ppm chlorine solution. The 500 ppm solution can be made by adding one part 5.25% bleach (household bleach) to 100 parts drinking water. For example 3-1/2 ounces of bleach can be added to 2-1/2 gallons drinking water. Materials should then be thoroughly rinsed before putting into service.

7. Prior to putting any potable water fixture currently or potentially used for drinking or cooking purposes, including but not limited to a bubbler, drinking fountain, or faucets, in operation, perform a "first draw" sampling of the water in accordance with 10 NYCRR subpart 67-4. First-draw samples shall be collected from all outlets, as defined in this Subpart. A first-draw sample volume shall be 250 milliliters (mL), collected from a cold water outlet before any water is used. All first-draw samples shall be analyzed by a laboratory approved to perform such analyses by the New York State Department of Health's Environmental Laboratory Approval Program (ELAP).
8. The water shall be motionless in the pipes for a minimum of 8 hours, but not more than 18 hours, before sample collection. The construction manager and owner shall be notified of any sample indicating a lead level of 15 micrograms per liter (equivalent to parts per billion, or ppb). Any potable water fixture connected to any such tested branch piping shall be taken out of service and conspicuous notice shall be made that the fixture is "OUT OF SERVICE".

END OF SECTION

## SECTION 221030 - PLUMBING SPECIALTIES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Provide all materials and installation for plumbing specialties and other normal components that make the systems complete, operable, code compliant and acceptable to the authorities having jurisdiction.
- B. Within building domestic water, sanitary waste and storm drainage systems; floor drains, floor sinks, hub drains, roof drains, cleanouts, backflow preventers, vacuum breakers, pressure regulating valves, water hammer arrestors, wall hydrants, hose bibbs, trap primer units, strainers, temperature gauges, pressure gauges
- C. This Section includes the following plumbing specialties:
  - 1. Floor Drains.
  - 2. Floor Sinks.
  - 3. Roof Drains.
  - 4. Cleanouts.
  - 5. Water Hammer Arresters.
  - 6. Wall Hydrants.
  - 7. Hose Bibbs.
  - 8. Air admittance valves.
  - 9. Strainers.
  - 10. Thermometers.
  - 11. Pressure Gauges.
  - 12. Drain Valves.
  - 13. Thermostatic Mixing Station.
  - 14. Domestic Recirculation Pump.
  - 15. Backflow Preventer.

#### 1.2 REFERENCE STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
  - 1. New York State Plumbing Code.

2. ANSI/NSF Standard 61 - Drinking Water System Components - Health Effects.
  3. ANSI/NSF Standard 372 – Lead Content in domestic water systems
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. UL Compliance: UL 778 for motor-operated water pumps.

### 1.3 QUALITY ASSURANCE

- A. All materials shall be new, undamaged, and free of rust. Protect installed products and associated materials during progression of the construction period to avoid clogging with dirt, and debris and to prevent damage, rust, etc. Remove dirt and debris as work progresses.
- B. Manufacturer Qualifications: Company shall have minimum three years documented experience specializing in manufacturing the products specified in this section.
- C. NSF Compliance:
1. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

### 1.4 SUBMITTALS

- A. Product Data:
1. Provide Code and Standards compliance, component dimensions, service sizes and finishes.
- B. Record Documents:
1. Manufacturer's certification documentation for backflow preventers.
  2. Submit proposed location of access panels which vary from quantities or locations indicated on Contract Drawings.
  3. Provide full written description of manufacturer's warranty.
  4. Record actual locations of plumbing specialties installed.
- C. Operation and Maintenance Data:
1. Include testing procedures for backflow preventers, adjustment procedures for water pressure regulating valves.
  2. Include installation instructions, exploded assembly views, servicing requirements, inspection data, installation instructions, spare parts lists, replacement part numbers and availability, location and contact numbers for service, for all plumbing specialties installed.

### 1.5 DELIVERY, STORAGE and HANDLING

- A. Accept specialties on site in shipping containers and maintain in place until installation.
- B. Provide temporary protective coating and end plugs on valves not packaged within containers. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work and isolating parts of completed system.
- D. Protect all materials before and after installation from exposure to rain, freezing temperatures and direct sunlight. EXCEPTION: Materials manufactured for installation within exterior environments.

## PART 2 PRODUCTS

### 2.1 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
- B. Provide plumbing specialties as indicated and scheduled on the Contract Drawings and as specified herein. All materials and work shall meet or exceed all applicable Federal and State requirements and conform to adopted codes and ordinances of authorities having jurisdiction.
- C. Pressure and temperature ratings of plumbing specialties shall be suitable for the anticipated system pressures and temperatures in which they are installed.
- D. All materials within domestic water distribution systems that may come in contact with the potable water delivered shall comply with ANSI/NSF Standard 61.
- E. All brass and bronze plumbing specialties within domestic water distribution systems that may come in contact with the potable water delivered shall certified lead free and have no more than 15% zinc content.
- F. Specialties of same type shall be product of one manufacturer.

### 2.2 acceptable manufacturers

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following for each type:
  - 1. Floor Drains: Wade, Zurn, Smith, Josam.
  - 2. Floor Sinks: Wade, Zurn, Smith, Josam.
  - 3. Roof Drains: Wade, Zurn, Smith, Josam.
  - 4. Wall/Floor Cleanouts: Wade, Zurn, Smith, Josam.
  - 5. Water Hammer Arrestors: Wade, Zurn, Smith, Josam.

6. Wall Hydrants: Wade, Zurn, Smith, Josam.
7. Hose Bibbs: Chicago, Leonard, Zurn.
8. Air admittance valves: Ayrlett, LLC, ProSet Systems Inc, RectorSeal, Studor, Inc.
9. Stainers: Conbraco, Metraflex, Wilkins, Zurn.
10. Temperature Gauges: Ashcroft, Trerice, Weksler.
11. Pressure Gauges: Ashcroft, Trerice, Weksler.
12. Drain Valves: Apollo, NIBCO, Milwaukee.
13. Thermostatic Mixing Station: Bradley, Lawler, Leonard.
14. Domestic Recirculation Pump: Taco, Bell & Gossett, Grundfos.
15. Backflow Preventer: Zurn, Watts, Apollo.

### 2.3 Floor drains (FD)

- A. Standard: ASME A112.6.3
- B. All floor drains shall be furnished and installed with all options and accessories required for a waterproof installation within the particular construction in which they are to be mounted.
- C. Each floor drain shall be provided with a deep-seal p-trap and trap guard unless noted otherwise.
- D. Floor drains installed for general floor area drainage within toilet rooms and other finished spaces shall have cast iron body with flange, adjustable top and sediment bucket, integral reversible clamping collar, seepage openings, 1/2" plugged primer tap, and 6" diameter stainless steel strainer with vandal proof screws.
- E. Floor drains installed for general floor area drainage and light to medium flow indirect equipment discharge within mechanical rooms shall have cast iron body with plugged 1/2" primer tap, integral clamping collar, seepage openings, adjustable 6" round top, 4" pipe connection and 11-1/2" diameter ductile iron loose set tractor grate.
- F. All floor drains shall be as sized on Contract Drawings.

### 2.4 Floor sinks (FS)

- A. Standard: ASME A112.6.7
- B. Floor sinks shall be provided with all options and accessories required for a waterproof installation within the particular construction in which they are to be mounted.
- C. Deep-seal p-trap and trap guard unless noted otherwise.
- D. 12"x12"x6" square body.
- E. 4" pipe connection



- F. Square slotted ½ grate.

2.5 Roof drains (RD)

- A. Standard: ASME A112.6.4
- B. Primary roof drains shall be furnished and installed with all options and accessories required for a waterproof installation within the particular construction in which they are to be mounted.
- C. 15-inch cast iron body with sump
- D. Removable cast iron or bronze dome strainer
- E. Flashing clamp and gravel stop
- F. Top-set deck plate with adjustable extension and drain receiver.
- G. Provide overflow roof drains with internal water dam.
- H. Roof drains shall be sized as indicated on Contract Drawings.

2.6 Cleanouts:

- A. Cleanouts shall be the same nominal size as the pipe they serve up to four inches. For pipes larger than four inches nominal size, the size of cleanouts shall be six inches.
- B. Cleanouts shall have tapered cast brass or bronze plug providing gas and watertight seal.
- C. Interior floor cleanouts shall have scoriated, adjustable top. Provide carpet marker when installed in areas to be covered by carpet.
- D. Exterior cleanouts at grade shall have scoriated cast iron top.
- E. Wall cleanouts shall be provided with stainless steel access covers of adequate size to allow rodding of drainage system. Wall cleanouts incorporating cover screws that extend completely through the access plug are not acceptable.

2.7 WATER HAMMER ARRESTORS (Shock Absorbers):

- A. Nesting type bellows operated water hammer arrestor with male N.P.T. connection. Bellows and body casing made of Type 304 stainless steel. Water hammer arrestors shall be lead free and certified to the PDI WH-201 Standard and ASSE Standard 1010.
- B. Arrestors shall be designed and manufactured for a maximum working temperature of 250F and maximum operating pressure of 125 P.S.I.G.

- C. All arrestors shall be designed and approved for sealed wall installation without an access panel.

2.8 WALL HYDRANTS (wh)

- A. Standard: ASME A112.21.3M
- B. Encased anti-siphon, automatic draining wall hydrant for flush installation, bronze casing, all bronze interior parts, non-turning operating rod with free-floating compression closure valve, replaceable bronze seat and seat washer, and combination 3/4 female or 1 male straight IP inlet. Nickel bronze box and hinged cover with operating key lock and "WATER" cast on cover.

2.9 non freeze WALL HYDRANTS (nfwh)

- A. Standard: ASME A112.21.3M
- B. Encased anti-siphon, automatic draining wall hydrant for flush installation. Complete with non-freeze type integral backflow preventer, bronze casing, all bronze interior parts, non-turning operating rod with free-floating compression closure valve, replaceable bronze seat and seat washer, and combination 3/4 female or 1 male straight IP inlet. Nickel bronze box and hinged cover with operating key lock and "WATER" cast on cover.

2.10 HOSE BIBBS (HB)

- A. Standard: ASME A112.18.1
- B. Bronze body, replaceable bronze seat, NPS 3/4 threaded inlet. Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
  - 1. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
  - 2. Finish for Service Areas: Rough bronze.
  - 3. Finish for Finished Rooms: Chrome or nickel plated.
  - 4. Operation for Equipment Rooms: Wheel handle or operating key.
  - 5. Operation for Service Areas: Wheel handle.
  - 6. Operation for Finished Rooms: Operating key.
  - 7. Include operating key with each operating-key hose bibb.
  - 8. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.11 AIR ADMITTANCE VALVES (aav)

- A. Fixture Air-Admittance Valves:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Ayrlett, LLC.
- b. ProSet Systems Inc.
- c. RectorSeal.
- d. Studor, Inc.
2. Standard: ASSE 1051, Type A for single fixture or Type B for branch piping.
3. Housing: Plastic.
4. Operation: Mechanical sealing diaphragm.
5. Size: Same as connected fixture or branch vent piping.

#### 2.12 strainers

- A. Pressure Rating: 125 psig minimum, unless otherwise indicated.
- B. Body: Lead free bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.
- C. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
- D. Screen: Stainless steel with round perforations, unless otherwise indicated.
- E. If retaining more than one screen size, indicate screen size on Drawings.
- F. Perforation Size:
  1. Strainers NPS 2 and Smaller: 0.020 inch.
  2. Strainers NPS 2-1/2 to NPS 4: 0.045 inch.
- G. Drain: Factory-installed, hose-end drain valve.

#### 2.13 thermometers

- A. Thermometers shall be vapor or liquid actuated, direct-mounted, universal adjustable angle dial type with stainless steel or cured polyester powder coated cast aluminum case, stainless steel friction ring and glass window. Dial face shall be white with black figures; pointer shall be friction adjustable type. Movement shall be brass with bronze bushings. Bourdon tube shall be phosphor bronze with a brass socket.
- B. Thermometer range shall be 30 - 240° Fahrenheit and have an accuracy of  $\pm 1$  scale division.
- C. Dial face shall be 4½" diameter where installed within eight feet of floor level and 6" diameter where installed higher than six feet above floor level. Provide remote read-out gauges for isolated or hard to access monitoring points.
- D. Provide a stainless steel separable thermowell for each thermometer.

- E. Thermometers shall have a sensing bulb with an insertion length of roughly half of the pipe diameter; minimum insertion length shall be 2". Thermometers installed on tanks shall have a minimum insertion length of 5".
- F. Where insulation thickness exceeds 2", provide proper bulb length and an extension neck separable thermowell. The extension neck shall be at least 2" long.

#### 2.14 PRESSURE GAUGES

- A. Gauges shall comply with ASME B40.1, Grade 2A, and have  $\pm 0.5$  percent of full scale accuracy, with type 304 stainless steel or aluminum case, lead free bronze or stainless steel wetted parts and brass socket. Dial face shall be 3½" diameter where installed within six feet of floor level and 6" diameter where installed higher than eight feet above floor level. Dial face shall be aluminum with white background, black graduations and black markings. Pointer shall be adjustable with black finish. Provide remote read-out gauges for isolated or hard to access monitoring points.
- B. Units of measure shall be in pounds per square inch (psi). The proper range shall be selected so that the average operating pressure falls approximately in the middle of the scale selected.
- C. All pressure gauges shall be equipped with brass or stainless steel needle valves and pressure snubbers.

#### 2.15 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves: Standard: MSS SP-110 for standard-port, two-piece ball valves.
  - 1. Pressure Rating: 400-psig minimum CWP.
  - 2. Size: NPS 3/4.
  - 3. Body: Copper alloy.
  - 4. Ball: Chrome-plated brass.
  - 5. Seats and Seals: Replaceable.
  - 6. Handle: Vinyl-covered steel.
  - 7. Inlet: Threaded or solder joint.
  - 8. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

#### 2.16 thermostatic mixing station (tms)

- A. Recirculation station consisting of high/low thermostatic mixing valve in combination with piping assembly, inlet/outlet shutoff valves, pressure/temperature gauges, circulating pump, balancing valve, aquastat, and GFCI outlet. All components pre-assembled to enamel coated strut and tested by manufacturer.

- B. High-Low thermostatic mixing valve assembly shall consist of a liquid-filled thermostat and a stainless steel piston and liner assembly with positive shutoff of hot water when cold water supply fails. Valve will restrict flow of cold water in the event of loss or interruption of the hot water supply. All flow is shut off in the event of thermostat failure. Construction shall be bronze body and cap with replaceable corrosion resistant components, including stainless steel piston and liner. Valve shall come equipped with integral checkstops, removable strainers, and thermometer. Liquid filled thermostat shall be warranted for a period of 10 years.
  - 1. ASSE Listed 1017.
  - 2. Lead Free: Comply with requirements of NSF/ANSI 372.
  - 3. High-low thermostatic valve with dial thermometer and adjustable setpoint range (90F - 120F).
  - 4. Full port ball valve shutoffs on inlets and outlets.
  - 5. Temperature/pressure gauges on inlets.
  - 6. Return line with circulating pump, balancing valve and check valves.

#### 2.17 domestic recirculation pump

- A. Description: Factory-assembled and -tested, in-line, close-coupled, canned-motor, sealless, overhung-impeller centrifugal pumps. All parts that may come in contact with the potable water delivered shall comply with ANSI/NSF Standard 61 and NSF 372.
- B. Pump Construction:
  - 1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge type with motor and impeller on common shaft and designed for installation with pump and motor shaft horizontal.
  - 2. Minimum Working Pressure: 125 psig.
  - 3. Maximum Continuous Operating Temperature: 220 deg F.
  - 4. Casing: Lead free bronze or stainless steel, with flange connections.
  - 5. Impeller: stainless steel.
  - 6. Shaft: Stainless steel.
  - 7. Motor: High efficiency ECM.
  - 8. Control: Differential Temperature

#### 2.18 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principle Backflow Preventers:
  - 1. Standard: ASSE 1013, NSF/ANSI 61 and NSF 372.
  - 2. Operation: Continuous-pressure applications.
  - 3. Design Flow Rate: 120 gpm.
  - 4. Pressure Loss at Design Flow Rate: 10 psig for sizes NPS 2 and smaller; 12 psig for NPS 2-1/2 and larger.
  - 5. Body: Bronze for NPS 2 and smaller; stainless steel for NPS 2-1/2 and larger.

6. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
7. Configuration: Designed for horizontal, straight-through flow.
8. Accessories:
  - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
  - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
  - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.
    - 1) Double-Check, Backflow-Prevention Assemblies:
      - a) Standard: ASSE 1015, NSF/ANSI 61 and NSF 372.
      - b) Operation: Continuous-pressure applications, unless otherwise indicated.
      - c) Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
      - d) Design Flow Rate: 200 gpm
      - e) Pressure Loss at Design Flow Rate: 10 psi for NPS 2 and smaller; 12 psi for NPS 2-1/2 and larger.
      - f) Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and larger.
      - g) End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.
      - h) Configuration: Designed for horizontal, straight through flow.
      - i) Accessories: Ball valves with threaded ends on inlet and outlet of NPS 2 and smaller; OS&Y gate valves with flanged ends on inlet and outlet of NPS 2-1/2 and larger.

### PART 3 EXECUTION

#### 3.1 PREPARATION

- A. Coordinate cutting and forming of roof and floor construction to receive drains with General Contractor.
- B. Verify location of equipment and housekeeping pads prior to installation of floor drains. Relocation due to misplacement shall be at Contractor's expense.

#### 3.2 INSTALLATION

- A. General
  1. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

2. Install plumbing specialties in accordance with manufacturer's published instructions.
- B. Drains and Cleanouts
1. Extreme care shall be used to set the top elevation of floor drains and floor sinks to meet the low point elevation of the finished floor.
  2. Pipe connections to roof drains, above grade floor drains and floor sinks shall not directly contact or be encased in concrete.
  3. Final mounting of interior cleanout top or access cover shall be set flush with the finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil.
  4. Encase exterior cleanouts within 14" x 14" x 6" thick reinforced concrete pad. Set top flush with finished grade surface.
  5. Locate cleanouts with required clearance for rodding of drainage system.
- C. Water Hammer Arrestors (Hydraulic Shock Absorbers)
1. Provide hydraulic shock absorbers in cold and hot water supply lines to each fixture branch, battery of fixtures and at each automatic, solenoid-operated or quick-closing valve serving equipment.
  2. Locate and size hydraulic shock absorbers in accordance with PDI-WH-201 Standard and manufacturer's published recommendations.
- D. Thermostatic Mixing Valve
1. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
  2. Equipment Nameplates and Signs: Install equipment nameplate or sign on or near each unit.
  3. Provide explanatory text on signs. Identify units. Distinguish among units, inform operator of operating requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
  4. Set field-adjustable temperature set points of temperature-actuated water mixing valves. Adjust set point within allowable temperature range.
  5. Test and adjust installation.
  6. Remove and replace malfunctioning thermostatic mixing valves and retest.
  7. Engage a factory-authorized service representative to perform startup service.
    - a. Complete installation and startup checks according to manufacturer's written instructions.
    - b. Provide written start-up report.
    - c. Adjust settings for proper operation.
- E. Backflow Preventers
1. Adequate clearances from floors, ceilings and walls must be provided to access the test cocks and to allow the repair and/or removal of the relief valve and check valves; as follows:

- a. All assemblies shall be installed with a centerline height from 30 inches to 60 inches above the floor. Any installation at a greater height shall be provided with a fixed platform, a portable scaffold or a lift meeting OSHA standards.
- b. All RPZ devices must have an 18 inch minimum clearance between the bottom of the relief valve and the floor to prevent submersion and provide access for servicing and relief valve.
- c. A minimum of 12 inches of clear space shall be maintained above the assembly to allow for servicing check valves and for operation of shut-off valves.
- d. A minimum of 30 inches of clear space shall be maintained between the front side of the device and the nearest wall or obstruction.
- e. At least 8 inches clearance should be maintained from the back side of the device to the nearest wall or obstruction. This clearance may need to be increased for models that have side mounted test cocks or relief valves that would be facing the back wall.
- f. All assemblies shall be adequately supported and/or restrained to prevent lateral movement. Pipe hangers, braces, saddles, stanchions, piers, etc., should be used to support the device and should be placed in a manner that will not obstruct the function of or access to the relief valve. Relief valve shall be piped to an air gap fitting.

END OF SECTION



## SECTION 221613 - NATURAL GAS PIPING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Pipes, tubes, and fittings.
  - 2. Piping specialties.
  - 3. Piping and tubing joining materials.
  - 4. Valves.
  - 5. Pressure regulators.

#### 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 Codes and regulations

- A. NFPA 54, National Fuel Gas Code.
- B. NFPA 70, National Electrical Code.
- C. NFPA 72, National Fire Alarm Code.
- D. Americans with Disabilities Act

#### 1.4 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 Pressure within Buildings: 0.5 psig or less.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
  - 1. Piping specialties.
  - 2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
  - 3. Pressure regulators. Indicate pressure ratings and capacities.
  - 4. Dielectric fittings.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

#### 1.7 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.

#### 1.8 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.
- D. Protect stored PE pipes and valves from direct sunlight.

#### 1.9 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 five (5) 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.

#### 1.10 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. Comply with requirements in Division 08 Section "Access Doors and Frames."

### PART 2 PRODUCTS

#### 2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
  1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
  2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
  3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
  4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
    - a. Material Group: 1.1.
    - b. End Connections: Threaded or butt welding to match pipe.
    - c. Lapped Face: Not permitted underground.
    - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
    - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless-steel underground.
  5. Mechanical Couplings:
    - 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) Dresser Piping Specialties; Division of Dresser, Inc.
      - 2) Smith-Blair, Inc.
    - b. Stainless-steel flanges and tube with epoxy finish.
    - c. Buna-nitrile seals.
    - d. Stainless-steel bolts, washers, and nuts.
    - e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

- f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.
- B. PE Pipe: ASTM D 2513, SDR 11.
  - 1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
  - 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
  - 3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
    - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
    - b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B, with corrosion-protective coating covering.
    - c. Aboveground Portion: PE transition fitting.
    - d. Outlet shall be threaded or flanged or suitable for welded connection.
    - e. Tracer wire connection.
    - f. Ultraviolet shield.
    - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
  - 4. Transition Service-Line Risers: Factory fabricated and leak tested.
    - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
    - b. Outlet shall be threaded or flanged or suitable for welded connection.
    - c. Bridging sleeve over mechanical coupling.
    - d. Factory-connected anode.
    - e. Tracer wire connection.
    - f. Ultraviolet shield.
    - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

## 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. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

## 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 VALVES

- A. All valves shall be designed, manufactured and approved for natural gas service.
- B. Line Shut-off Valves sizes 2 inches and smaller shall be iron body lubricated plug valve conforming to ASTM-A-126, U.L. Listed and A.G.A. Approved for natural gas service with threaded ends, wrench operation, rated for 200 WOG service pressure and -20 to 200 degrees F., manufactured by Resun Model R-1430 or Nordstrom Model 142.
- C. Line Shut-off Valves sizes 2½ inches and larger shall be iron body lubricated plug valve conforming to ASTM-A-126, U.L. Listed and A.G.A. Approved for natural gas service with flanged ends, wrench operation, rated for 200 WOG service pressure and -20 to 200 degrees F., manufactured by Resun Model R-1431 or Nordstrom Model 143.
- D. Appliance/Equipment Shut-off Valves at local connections sizes 2 inches and smaller shall be bronze body, full port ball or butterfly type, U.L. Listed and A.G.A. Approved for natural gas service with threaded ends, quarter turn lever handle operation, rated for 175 W.O.G. service pressure and 30 to 275 degrees F., manufactured by Nibco Model T585-70-UL, Model T580-70-UL or Milwaukee Model BB2-100.

## 2.5 PRESSURE REGULATORS

- A. General Requirements:
  1. Single stage and suitable for natural gas.
  2. Steel jacket and corrosion-resistant components.
  3. Elevation compensator.
  4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.
- B. Line Pressure Regulators: Comply with ANSI Z21.80.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

- a. Actaris.
    - b. American Meter Company.
    - c. Eclipse Combustion, Inc.
    - d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
    - e. Invensys.
    - f. Maxitrol Company.
    - g. Richards Industries; Jordan Valve Div.
  2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
  3. Springs: Zinc-plated steel; interchangeable.
  4. Diaphragm Plate: Zinc-plated steel.
  5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
  6. Orifice: Aluminum; interchangeable.
  7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
  8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
  9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
  10. Overpressure Protection Device: Factory mounted on pressure regulator.
  11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
  12. Maximum Inlet Pressure: 2 psig
- C. Appliance Pressure Regulators: Comply with ANSI Z21.18.
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. Canadian Meter Company Inc.
    - b. Eaton Corporation; Controls Div.
    - c. Harper Wyman Co.
    - d. Maxitrol Company.
    - e. SCP, Inc.
  2. Body and Diaphragm Case: Die-cast aluminum.
  3. Springs: Zinc-plated steel; interchangeable.
  4. Diaphragm Plate: Zinc-plated steel.
  5. Seat Disc: Nitrile rubber.
  6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
  7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
  8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.

9. Maximum Inlet Pressure: 1 psig

### 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 NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 requirements for prevention of accidental ignition.

#### 3.3 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
  - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, natural-gas piping according to ASTM D 2774.
- D. 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.
- E. Install fittings for changes in direction and branch connections.

#### 3.4 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 54 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. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
    - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
    - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.
    - 3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
    - 4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
      - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
    - 5. Prohibited Locations:
      - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
      - b. Do not install natural-gas piping in solid walls or partitions.
  - Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
  - R. Connect branch piping from top or side of horizontal piping.
  - S. 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.
  - T. Do not use natural-gas piping as grounding electrode.
  - U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
  - V. Install sleeves for piping penetrations of walls, ceilings, and floors.
  - W. Install sleeve seals for piping penetrations of concrete walls and slabs.
- 3.5 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.
- E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.
- F. 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.

### 3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hangers and supports specified in Section 220529 – Supports and Sleeves.
- 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.

### 3.7 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.

### 3.8 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 220553 – Plumbing Identification 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.

### 3.9 PAINTING

- A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.
- B. Paint exposed, interior and exterior metal piping, 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 (semigloss).
    - d. Color: Yellow.
- C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

### 3.10 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Test, inspect, and purge natural gas according to NFPA 54 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.

### 3.11 NATURAL GAS PIPING SCHEDULE

- A. Underground natural-gas piping shall be the following:
  - 1. PE pipe and fittings joined by heat fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
- B. Aboveground natural-gas piping, NPS 2 and smaller, shall be the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints.
- C. Aboveground natural-gas piping, NPS 2-1/2 and larger, shall be the following:
  - 1. Steel pipe with wrought-steel fittings and welded joints.

END OF SECTION 221613

## SECTION 223500 - DOMESTIC-WATER HEAT EXCHANGERS

### 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. Frame-and-plate, domestic-water heat exchangers.
  - 2. Domestic-water, heat-exchanger accessories.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heat exchanger indicated.
- B. Shop Drawings:
  - 1. Wiring Diagrams: For power, signal, and control wiring.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic-water heat exchangers to include in emergency, operation, and maintenance manuals.

#### 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label heat-exchanger storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61 Annex G/NSF 372.

#### 1.6 COORDINATION

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

## 1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of domestic-water heat exchangers that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including heat exchanger, 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. Plate, Domestic-Water Heat Exchangers:
      - 1) Plate-and-Frame Type: One year(s).
    - b. Compression Tanks: One year(s).

## PART 2 PRODUCTS

### 2.1 PLATE, DOMESTIC-WATER HEAT EXCHANGERS

- A. Frame-and-Plate, Domestic-Water Heat Exchangers:
  - 1. Description: Assembly of nonfixed-position, heat-exchanger plates, with frame, for using heating hot water to heat domestic water.
  - 2. Working-Pressure Rating: 150 psig minimum.
  - 3. Frame:
    - a. Carrying and Guide Bars: Stainless steel
    - b. Fixed, Frame Plate; Pressure Plate; Support Column; and Nuts and Bolts: Carbon steel.
  - 4. Channel Plates:
    - a. Type: Single wall.
    - b. Material: Stainless steel.
    - c. Gasket Material: EPDM, suitable for potable water.
  - 5. Connections: Stainless steel suitable for potable water.
    - a. NPS 2 and Smaller: Threaded.
    - b. NPS 2-1/2 and Larger: Flanged.
  - 6. Protective Shroud: Steel, covering channel plates.
  - 7. Insulation: Complying with ASHRAE/IESNA 90.1, unless otherwise indicated, and suitable for operating temperature. Surround entire heat exchanger except connections.

### 2.2 DOMESTIC-WATER, HEAT-EXCHANGER ACCESSORIES

- A. Domestic-Water Compression Tanks:
  - 1. 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.
  - 2. 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 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    - c. Air-Charging Valve: Factory installed.
  - 3. Capacity and Characteristics:
    - a. Working-Pressure Rating: 150 psig
    - b. Capacity Acceptable: 10 gal. minimum.
    - c. Air Precharge Pressure: 60 psig.
- B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.
- C. Heat-Trap Fittings: ASHRAE 90.2.
- D. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than heat-exchanger working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- E. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than heat-exchanger working-pressure rating.
- F. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

## 2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heat exchangers specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test domestic-water heat exchangers to minimum of one and one-half times pressure rating before shipment.
- C. Domestic-water heat exchangers will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

## PART 3 EXECUTION

### 3.1 DOMESTIC-WATER, HEAT-EXCHANGER INSTALLATION

- A. Domestic-Water, Heat-Exchanger Mounting: Install domestic-water heat exchangers on concrete base.
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
  - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
  - 5. Anchor heat exchangers to substrate.
- B. Install domestic-water heat exchangers 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 heat exchangers and on domestic-hot-water outlet piping.
  - 2. Install shutoff valves on heating hot-water piping to heat exchangers.
- C. Install temperature and pressure relief valves in top portion of storage-tank shells of domestic-water heat exchangers with domestic-water storage. Use relief valves with sensing elements that extend into shells. Extend 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.
- D. Install combination temperature-and-pressure relief valves in water piping for domestic-water heat exchangers without storage. Extend 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 heat-exchanger 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 heat exchangers that do not have tank drains.
- F. Install thermometer on each domestic-water, heat-exchanger, inlet and outlet piping, and install thermometer on each domestic-water, heat-exchanger, heating-fluid inlet and outlet piping.
- G. Install pressure gages on domestic-water, heat-exchanger, heating-fluid piping.



- H. Fill domestic-water heat exchangers with water.
- I. Charge domestic-water compression tanks with air.

### 3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping."
- B. Comply with requirements for heating hot-water piping specified in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties."
- C. Comply with requirements for steam and condensate piping specified in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties."
- D. Drawings indicate general arrangement of piping, fittings, and specialties.
- E. Where installing piping adjacent to domestic-water heat exchangers, allow space for service and maintenance of heat exchangers. Arrange piping for easy removal of domestic-water heat exchangers.

### 3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

### 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 heat exchangers will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- 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 heat exchangers.

END OF SECTION

## SECTION 224200 - PLUMBING FIXTURES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Water closets
  - 2. Lavatories.
  - 3. Sinks.

#### 1.2 DEFINITIONS

- A. Accessible Fixture: Emergency plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.
- C. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.
- D. Tepid: Moderately warm.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals. For emergency plumbing fixtures to include in operation and maintenance manuals.

#### 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Flushometer Repair Kits: Six (6) of each type installed.
  - 2. Faucet Cartridges and O-rings: Six (6) of each type installed.

3. Toilet Seats: Six (6) of each type installed.

## PART 2 PRODUCTS

### 2.1 WATER CLOSETS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. American Standard America.
  2. Crane Plumbing, L.L.C.
  3. Gerber Plumbing Fixtures LLC.
  4. Kohler Co.
  5. Zurn Industries, LLC; Commercial Brass and Fixtures.
- B. Accessories:
  1. Flushometer: 1.28 gallon per flush, exposed chrome plated brass electronic sensor flush valve with mechanical override push button, 9VDC battery operated, adjustable sensor range, low battery indicator light, 24 hr. courtesy flush, vacuum breaker, adjustable tailpiece, spud coupling and flange for top spud connection. Control stop with internal siphon-guard protection, vandal resistant stop cap, and cast wall flange with set screw. Chloramine resistant gaskets and at least dual filtered diaphragm. Provide remote control for sensor adjustment. Zurn ZER6000AV-HET-CPM-MOB or approved equal.
  2. Toilet Seat: Elongated, white, open front seat with stainless steel check hinge. Zurn Z5955SS-EL or approved equal.
  3. Support:
    - a. Standard: ASME A112.6.1M.
    - b. Description: Waste-fitting assembly as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture.

### 2.2 LAVATORIES

- A. General:
  1. Comply with ASME A112.19.2/CSA B45.1.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. American Standard America.
  2. Crane Plumbing, L.L.C.
  3. Gerber Plumbing Fixtures LLC.
  4. Kohler Co.
  5. Zurn Industries, LLC; Commercial Brass and Fixtures.

- C. Description
  - 1. Nominal Size: 20"x18"
- D. Accessories:
  - 1. Faucet: Vandal resistant battery powered sensor faucet with infrared convergence-type proximity sensor; 0.5 GPM laminar flow, thermostatic mixing valve (ASSE 1070 Listed and CSA B125.70 Certified), certified lead-free, Zurn Z6955-XL-S or approved equal.
  - 2. Trim: ADA polished chrome offset grid strainer, loose key angle stops, cast brass chrome plated P-trap with cleanout.
  - 3. Support: ASME A112.6.1M, floor mounted concealed-arm carrier.

## 2.3 SINKS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Advance Tabco.
  - 2. Elkay Manufacturing Co.
  - 3. Griffin Products, Inc.
  - 4. Just Manufacturing.
- B. Accessories:
  - 1. Faucet: Two handle concealed undermount ADA faucet with 45 degree restricted swing spout and aerator, outlet height 10", reach 6-1/2", no spray, certified lead-free, Elkay LK2439 or approved equal.
  - 2. ADA drain fitting with strainer and offset tailpiece for sink and grid strainer with offset tailpiece for fountain, Elkay LKAD35/LK8&LKADOS or approved equal, loose key angle stops, cast brass chrome plated double bowl sink drain fitting and P-trap with cleanout.
  - 3. Thermostatic Mixing Valve: Thermostatic mixing valve with 1/2" inlets/outlet and integral checks, brass body with dual stainless-steel strainers, vandal-resistant cap/temperature adjustment handle, wall mounting bracket, standard finish rough brass. Dual certified to ASSE 1017/1070. (.5 - 14 GPM), 60 - 140°F temperature control range, Symmons Maxline Model 5-225 Series or approved equal.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

- B. Examine walls and floors for suitable conditions where plumbing fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install plumbing fixtures level and plumb according to roughing-in drawings and manufacturers installation instructions.
- B. Install supports, affixed to building substrate.
- C. Wall Flange and Escutcheon Installation:
  - 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
  - 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
- D. Joint Sealing:
  - 1. Seal joints between plumbing fixtures and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
  - 2. Match sealant color to water-closet color.
- E. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks and lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."
- F. Fasten fixtures to substrate where necessary.
- G. Install shutoff valves in water-supply piping to fixtures. Install valves chained or locked in open position if permitted. Install valves in locations where they can easily be reached for operation.

### 3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Connect output from water-tempering equipment to emergency plumbing fixtures.
- C. Allow space for service and maintenance.

### 3.4 FIELD QUALITY CONTROL

- A. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities.
- B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
  2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
- C. Emergency plumbing fixtures and water-tempering equipment will be considered defective if they do not pass tests and inspections.

### 3.5 ADJUSTING

- A. Operate and adjust plumbing fixtures and controls. Replace damaged and malfunctioning fittings, and controls.
- B. Install fresh batteries in battery-powered, electronic-sensor mechanisms.
- C. Adjust safety equipment temperature settings.
- D. For Electric Water Coolers adjust fixture flow regulators for proper flow and stream height. Adjust pressure water-cooler temperature settings.
- E. Adjust pressure water-cooler temperature settings.

### 3.6 CLEANING AND PROTECTION

- A. Replace fixtures with damaged finishes.
- B. Clean plumbing fixtures and fittings with manufacturers' recommended cleaning methods and materials.
- C. Install protective covering for installed plumbing fixtures and fittings.
- D. Do not allow use of plumbing fixtures for temporary facilities.

END OF SECTION

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## SECTION 230500 - GENERAL MECHANICAL REQUIREMENTS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this and all Division 23 Sections.

#### 1.2 PLANS AND SPECIFICATIONS

- A. All work under this title, on drawings or specified, is subject to the general and special contract conditions for the entire project, and the contractor for this portion of the work is required to refer especially thereto, and to the architectural drawings.
- B. Drawings are diagrammatic and specifications are complementary and must be so interpreted to determine the full scope of work under this heading. Wherever any material, article, operation or method is either specified or shown on the drawings, this contractor is required to provide each item and perform each prescribed operation according to the designate quality, qualification or condition, furnishing all necessary labor, equipment or incidentals.
- C. Wherever the designation "Architect" appears, it shall imply Architect or Engineer. Wherever the term "Contractor" or "MC" appears, it shall imply the Contractor responsible for Division 23, Mechanical Work.

#### 1.3 CONFLICTS

- A. If, in the interpretation of contract documents, it appears that the drawings and specifications are not in agreement, the Contractor is to contact the Engineer. The Engineer shall be the final authority. Addenda supersede the provisions which they amend.
- B. In the absence of a written clarification by the engineer, the Contractor must install his work in accordance with the more stringent and/or costly condition. Contractor assumes full responsibility for any and all items furnished and installed without the written approval by the Architect or Engineer. Under no circumstances will a change order be approved for work installed that was not approved by the Architect or Engineer.

#### 1.4 DIMENSIONS, LAYOUTS AND OBSTACLES

- A. Verify dimensions and elevations from actual field measurements after building construction has sufficiently progressed.
- B. Assume full and final responsibility for the accuracy of any or all work performed under this Division and make repairs and corrections as required or directed at no extra cost to the Owner.
- C. Layouts of piping, ductwork, and equipment shown on drawings are diagrammatic and shall be construed as such. DO NOT SCALE DRAWINGS. Contractor shall field verify all existing conditions prior to fabrication and installation of material. It is recommended that the contractor verify all existing conditions prior to submitting a proposal. Lack of field verification does not constitute a basis for additional monies during construction. Contractor assumes full responsibility for completeness of installation including coordination of work with other trades.
- D. Make actual installations in accord with said layouts, but with necessary deviations as directed or required by job conditions and field measurements in order to produce a thoroughly integrated and practical job upon completing, but make deviations only with specific approval of the Engineer/Architect.
  - 1. Take particular care to coordinate all piping and ductwork under this Division to prevent conflict and remove and relocate work as may be made necessary by such conflict at no extra cost to the Owner.
  - 2. Unless expressly permitted by the Engineer/Architect or shown otherwise on the Drawings, all piping, ducts and similar items shall be installed so that they are concealed except as permitted by the Engineer/Architect in service rooms noted on the Drawings.
- E. The Owner or Owner's Representative reserves the right to relocate terminal equipment six (6) feet in any direction from locations indicated on plans, before roughing-in, with no change in contract price.

#### 1.5 REVIEW OF MATERIAL

- A. Items specified have been checked by the Engineer for performance and space limitation.
- B. In order for Engineer to consider "equal", Contractor must certify by letter that he has checked the product for conformance to specifications and space limitations and assumes full responsibility thereafter.
- C. Engineer, not Contractor or Vendor, shall be the final judge of equal materials.
- D. Substitutions are defined as any manufacturer and/or model not indicated in drawings or specifications. Requests for substitutions must be made in writing ten (10) days prior to bid date so that an addendum may reach all contractors.

- E. If substitutions are proposed after the bids are received, the Contractor shall state amount of credit to the Owner for substitution. Substitutions that are considered equal by the Contractor and carried in bid without approval by Engineer shall be the responsibility of the Contractor. The Engineer and/or Owner shall not be made liable or responsible for losses incurred by the Contractor, due to the rejection of said items for installation.
- F. Where equipment requiring different arrangement or connections other than as indicated is acceptable, it shall be the responsibility of this Contractor to furnish revised layouts, and install the equipment to operate properly and in harmony with the intent of the drawings and specifications. All changes in the work required by the different arrangement shall be done at no additional cost to the Owner, including but not limited to structural steel modifications. Control and power wiring modifications required by Contractor, imposed modifications, and the additional cost of these modifications, shall be the responsibility of this Contractor.
- G. Upon review of equipment list by Engineer, copies of submittal prints shall be forwarded to Engineer within 30 days.

#### 1.6 PERMITS, CODES AND ORDINANCES

- A. The Contractor shall arrange and pay for all permits, inspections, etc., as required by local utilities or applicable agencies.
- B. All work and material shall be in complete accordance with the ordinances, regulations, codes, etc., of all political entities exercising jurisdictions, specifically including the NYS Energy Code.

#### 1.7 COORDINATION WITH OTHER TRADES

- A. Check mechanical drawings with all other trades including electrical, plumbing, fire protection and general construction.
- B. Anticipate and avoid interferences with other trades.
- C. Take particular care to coordinate all piping, ductwork, plumbing and major electrical components above ceiling, to prevent conflict. Remove and relocate work as may be made necessary by such conflict, at no extra cost to the Owner. The use of coordination drawings is recommended but may not be required (refer to Division 1 for additional requirements). Lack of coordination drawings assumes contractor has verified and coordinated all work associated with installation.
- D. Obtain decision for approval from project Engineer for proposed group installation before proceeding, and for clearance in structure and finish of the building.
- E. Verify with drawings all ductwork and equipment layout in concealed areas.

- F. Running pipe and ductwork over electrical equipment and in elevator machine rooms is prohibited.
- G. The Contractor to coordinate with, receive and install, Owner furnished equipment where indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Delivery of Materials: Make provisions for delivery and safe storage of all materials. Check and properly receipt material to be "furnished by others" to contractor, and assume full responsibility for all materials while in storage with full visible identification and information.

1.9 PROJECT CONDITIONS

- A. Existing Conditions: Field verify existing conditions that will determine exact locations, distances, levels, dimensions, elevations, etc. Review all drawings of other trades and report any conflicts to the Architect/Engineer which will affect the project cost. Lack of field verification does not constitute a basis for additional monies during construction. Contractor assumes full responsibility for completeness of installation including coordination of work with other trades.
- B. The existing facility will be occupied and functioning during the entire duration of construction. Care shall be taken when working in or around occupied spaces. There will be no interruption in mechanical systems or utilities without written approval from the Owner.

1.10 MISCELLANEOUS SUPPORT

- A. Mechanical Contractor is responsible for providing all miscellaneous support components necessary for properly supporting equipment including hangers, rods, anchors, steel, etc.

END OF SECTION

## SECTION 230502 - MECHANICAL DEMOLITION

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Description of Work: Provide mechanical removal work as indicated and as required for removal and/or abandonment of systems, equipment and devices, etc. made obsolete by this Project, and as required for removal and remodeling by other trades.

#### 1.2 EXISTING CONDITIONS

- A. General: In general, existing mechanical systems, equipment and devices are not shown on the Drawings unless pertinent to the demolition and/or remodeling work. Existing conditions, where indicated, are based on casual field observations and/or historical plans prepared as part of original building fit-out, and must be verified. Report any discrepancies to the Engineer before disturbing the existing installation.
  - 1. Examination: Prior to bidding, examine the site to determine all actual observable conditions. No additional compensation will be granted on account of extra work made necessary by the Contractor's failure to investigate such existing conditions.

#### 1.3 COORDINATION

- A. Adjoining Areas: It is expected that the Contractor understands that adjoining areas of the building (or project site) must remain in operation and mechanical systems and services must remain in operation at all times, unless specifically approved otherwise.
- B. Scheduling: Mechanical removal work shall be scheduled in conjunction with the other trades. Contractor cooperation will be expected under all conditions.
- C. Area Limits: Construction traffic and removal of debris will be limited to specific areas and routes. Confirm with the Owner.

#### 1.4 ADJACENT MATERIALS

- A. Protection: During execution of removal work, primary consideration shall be given to protecting from damage, building structure, furnishings, finishes and the like, which are not specifically indicated to be removed.
- B. Repairs: Existing items or surfaces to remain, which are damaged as a result of this work shall be refinished, repaired or replaced to the satisfaction of the Owner, at no cost to the Contract.

## 1.5 TRANSIENT SERVICES

- A. Locate and identify any and all mechanical services passing through the project area which serve areas outside the work limits.
- B. Maintain all mechanical services to areas outside the work limits unless specifically authorized otherwise in writing by the Engineer or Owner's Representative. When transient services must be interrupted, provide temporary services for affected areas outside the work limits.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Patching: Materials used for patching shall be in conformance with the applicable sections of the Project Manual. Where materials are not specifically described, but required for proper completion of the Work, they shall be as selected by the Contractor, subject to approval of the Engineer.

## PART 3 EXECUTION

### 3.1 INSPECTION/VERIFICATION

- A. Inspection: Before commencing work of this Section, carefully inspect the project site and become familiar with existing systems and conditions.
- B. Items to be Salvaged: Verify with the Engineer and Owner's Representative, all systems, materials and equipment which are to be salvaged, and those which must be removed. The Owner reserves the right to salvage any or all existing mechanical materials and equipment at the project site. Items to be salvaged include, but are not limited to, the following:
  - 1. Albert Leonard Middle School
    - a. Exhaust Fans for reinstallation
  - 2. Columbus Elementary School
    - a. Ductless split system in main office – turn over to Owner.
  - 3. Trinity Elementary School
    - a. Exhaust Fans for reinstallation
    - b. Rooftop Unit for reinstallation
    - c. Condensing Units for reinstallation

### 3.2 COORDINATION

- A. Coordinate removal work with other trades, where applicable.

### 3.3 DEMOLITION

- A. General: Remove mechanical equipment, ductwork, piping, controls and related materials within the project work limits, as indicated.
- B. Disconnections: Disconnect all electrical devices and equipment located in wall, ceilings or floors scheduled for removal and other equipment, as indicated. Disconnect electrical connections to mechanical and other equipment being removed by other trades.
- C. Protection: Perform all removal work in such a manner so that damage to adjacent items and surfaces is minimized.
  - 1. Patching: When mechanical materials are removed, patch and finish surfaces to remain to match surrounding surfaces.

### 3.4 EXISTING MECHANICAL WORK TO REMAIN

- A. General: Protect and maintain access to existing mechanical work which must remain. Reinstall existing mechanical work disturbed.
- B. Reconnections: Where mechanical work in adjoining areas or mechanical work indicated to remain, becomes disconnected or affected by demolition work, reconnect as required, to restore original operation. Restoration work to comply with requirements for new work.

### 3.5 EXISTING MECHANICAL WORK TO BE RELOCATED

- A. General: Disconnect, remove, reinstall and reconnect existing equipment indicated to be relocated and where require to accommodate remodeling or new construction. Extend existing installations as required. Materials and methods used for relocations and extensions to conform to requirements for new work.

### 3.6 SHUTDOWNS

- A. General: All shutdowns to existing mechanical services to be scheduled and approved, in writing, by the Owner.

### 3.7 DISPOSITION OF EXISTING MATERIALS AND EQUIPMENT

- A. Items to Salvage: Material and equipment which is indicated (or directed by Owner) to be salvaged, shall be carefully removed and stored where directed on the site.
- B. Items to Reuse/Relocate: Carefully remove and store on site, all material and equipment indicated to be reused or relocated. Thoroughly clean, and make any necessary minor repairs to such equipment, prior to installation.

- C. Items to Remove: Remove and legally dispose of all other materials and debris resulting from demolition work on a daily basis.

### 3.8 CLEANING

- A. Remove from the Project Site all dirt, dust and debris resulting from removal operations on a daily basis. Refuse shall not be allowed to block or otherwise impair circulation in corridors, stairs, sidewalks, roadways or other traffic areas.

END OF SECTION



## SECTION 230513 - COMMON MOTOR REQUIREMENTS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

#### 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 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: Separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: Class F.
- I. 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.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

#### 2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
  - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
  - 2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
  - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

#### 2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
  - 1. Permanent-split capacitor.
  - 2. Split phase.
  - 3. Capacitor start, inductor run.
  - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: 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.

END OF SECTION 230513

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## SECTION 230515 - VARIABLE FREQUENCY DRIVES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes separately enclosed, pre-assembled, combination VFDs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type and rating of VFD indicated. Include features, performance, electrical ratings, operating characteristics, shipping and operating weights, and furnished specialties and accessories.
  - 1. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Each installed unit's type and details.
    - b. Factory-installed devices.
    - c. Enclosure types and details.
    - d. Nameplate legends.
    - e. Short-circuit current (withstand) rating of enclosed unit.
    - f. Features, characteristics, ratings, and factory settings of each VFD and installed devices.
    - g. Specified modifications.
      - 1) Schematic and Connection Wiring Diagrams: Indicate all field wiring required for the project.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VFDs 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 thermal-magnetic circuit breaker and MCP trip settings.
  - 2. Manufacturer's written instructions for setting field-adjustable overload relays.
  - 3. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor control modules.

4. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.

#### 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. Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

#### 1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. If stored in space that is not permanently enclosed and air conditioned, remove loose packing and flammable materials from inside controllers and install temporary electric heating, with at least 250 W per controller.

#### 1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without de-rating, under the following conditions unless otherwise indicated:
  1. Ambient Temperature: Not less than 14 deg F and not exceeding 104 deg F.
  2. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F
  3. Humidity: Less than 95 percent (non-condensing).
  4. Altitude: Not exceeding 3300 feet.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDs, and adjacent surfaces and other items.

#### 1.9 COORDINATION

- A. Coordinate features of motors, load characteristics, installed units, and accessory devices to be compatible with the following:

1. Torque, speed, and horsepower requirements of the load.
2. Ratings and characteristics of supply circuit and required control sequence.
3. Ambient and environmental conditions of installation location.

#### 1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace VFDs that fail in materials or workmanship within specified warranty period.
  1. Warranty Period: Five years from date of Substantial Completion.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURED UNITS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  1. ABB.
  2. AC Tech/Lenze
  3. Eaton Electrical Inc.; Cutler-Hammer Business Unit
  4. Square D.
- B. General Requirements for VFDs: Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508C.
- C. VFD Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.
  1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."
  2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
  3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
- D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.
- E. Output Rating: Three-phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

- F. Unit Operating Requirements:
  - 1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
  - 2. Input AC Voltage Unbalance: Not exceeding 3 percent.
  - 3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
  - 4. Minimum Efficiency: 96 percent at 60 Hz, full load.
  - 5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
  - 6. Minimum Short-Circuit Current (Withstand) Rating: 22 kA.
  - 7. Ambient Temperature Rating: Not less than 14 deg F and not exceeding 104 deg F.
  - 8. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F
  - 9. Humidity Rating: Less than 95 percent (non-condensing).
  - 10. Altitude Rating: Not exceeding 3300 feet.
  - 11. Vibration Withstand: Comply with IEC 60068-2-6.
  - 12. Overload Capability: 1.15 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
  - 13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
  - 14. Speed Regulation: Plus or minus 5 percent.
  - 15. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
  - 16. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
- G. Isolated Control Interface: Allows VFDs to follow remote-control signal over a minimum 40:1 speed range.
  - 1. Signal: Electrical.
- H. Internal Adjustability Capabilities:
  - 1. Minimum Speed: 5 to 25 percent of maximum rpm.
  - 2. Maximum Speed: 80 to 100 percent of maximum rpm.
  - 3. Acceleration: 0.1 to 999.9 seconds.
  - 4. Deceleration: 0.1 to 999.9 seconds.
  - 5. Current Limit: 30 to minimum of 150 percent of maximum rating.
- I. Self-Protection and Reliability Features:
  - 1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
  - 2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
  - 3. Under- and overvoltage trips.
  - 4. Inverter overcurrent trips.



5. VFD and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.
  6. Critical frequency rejection, with three selectable, adjustable deadbands.
  7. Instantaneous line-to-line and line-to-ground overcurrent trips.
  8. Loss-of-phase protection.
  9. Reverse-phase protection.
  10. Short-circuit protection.
  11. Motor overtemperature fault.
- J. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
- K. Bidirectional Auto Speed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
- L. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
- M. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- N. Integral Input Disconnecting Means and OCPD: NEMA KS 1, fusible switch with pad-lockable, door-mounted handle mechanism.
1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFD input current rating, whichever is larger.
  2. Auxiliary Contacts: NO/NC, arranged to activate before switch blades open.
  3. Auxiliary contacts "a" and "b" arranged to activate with circuit-breaker handle.
  4. NC alarm contact that operates only when circuit breaker has tripped.

## 2.2 CONTROLS AND INDICATION

- A. Status Lights: Door-mounted LED indicators displaying the following conditions:
1. Power on.
  2. Run.
  3. Overvoltage.
  4. Line fault.
  5. Overcurrent.
  6. External fault.

- B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.
  - 1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
- C. Historical Logging Information and Displays:
  - 1. Real-time clock with current time and date.
  - 2. Running log of total power versus time.
  - 3. Total run time.
  - 4. Fault log, maintaining last four faults with time and date stamp for each.
- D. Indicating Devices: Digital LCD display and additional readout devices as required, mounted flush in VFD door and connected to display VFD parameters including, but not limited to:
  - 1. Output frequency (Hz).
  - 2. Motor speed (rpm).
  - 3. Motor status (running, stop, fault).
  - 4. Motor current (amperes).
  - 5. Motor torque (percent).
  - 6. Fault or alarming status (code).
  - 7. PID feedback signal (percent).
  - 8. Set point frequency (Hz).
- E. Control Signal Interfaces:
  - 1. Electric Input Signal Interface:
    - a. A minimum of two programmable analog inputs: 0- to 10-V dc or 4- to 20-mA dc
    - b. A minimum of six multifunction programmable digital inputs.
  - 2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:
    - a. 0- to 10-V dc.
    - b. 4- to 20-mA dc.
    - c. Potentiometer using up/down digital inputs.
    - d. Fixed frequencies using digital inputs.
  - 3. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc or 4- to 20-mA, which can be configured for any of the following:
    - a. Output frequency (Hz).
    - b. Output current (load).
    - c. DC-link voltage (V dc).
    - d. Motor torque (percent).
    - e. Motor speed (rpm).

- f. Set point frequency (Hz).
  - 4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
    - a. Motor running.
    - b. Set point speed reached.
    - c. Fault and warning indication (over temperature or over current).
    - d. PID high- or low-speed limits reached.
- F. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFD status and alarms and energy usage. Allows VFD to be used with an external system within a multidrop LAN configuration; settings retained within VFD's nonvolatile memory.
  - 1. Network Communications Ports: Ethernet and RS-485.
  - 2. Embedded BAS Protocols for Network Communications: Contractor to confirm with Technology Contract and Owner's Representative; protocols accessible via the communications ports.

## 2.3 LINE CONDITIONING AND FILTERING

- A. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD at input terminals of VFCs to less than 8 percent and THD(V) to 5 percent.
- B. Input Line Conditioning: Based on the harmonic analysis study and report, provide input filtering, as required, to limit TDD and THD(V) at the defined PCC per IEEE 519.
- C. EMI/RFI Filtering: CE marked; certify compliance with IEC 61800-3 for Category C2.

## 2.4 BYPASS SYSTEMS

- A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.
- B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.
- C. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.
  - 1. Bypass Contactor: Load-break, IEC-rated contactor.
  - 2. Output Isolating Contactor: Non-load-break, IEC-rated contactor.

3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.
- D. Bypass Contactor Configuration: Full-voltage (across-the-line) type.
  1. NORMAL/BYPASS selector switch.
  2. HAND/OFF/AUTO selector switch.
  3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.
  4. Contactor Coils: Pressure-encapsulated type.
    - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
    - b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
  5. Control Circuits: 24-V ac; obtained from integral CPT, with primary and secondary fuses, with control power source of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.
    - a. CPT Spare Capacity: 50 VA.
  6. Overload Relays: NEMA ICS 2.
    - a. Solid-State Overload Relays:
      - 1) Switch or dial selectable for motor-running overload protection.
      - 2) Sensors in each phase.
      - 3) Class 20 tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
      - 4) Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
      - 5) Analog communication module.
    - b. NC/NO isolated overload alarm contact.
    - c. External overload reset push button.

## 2.5 ENCLOSURES

- A. VFD Enclosures: NEMA 250, to comply with environmental conditions at installed location.
  1. Dry and Clean Indoor Locations: Type 1.
  2. Outdoor Locations: Type 4.
  3. Kitchen Areas: Type 4X, stainless steel.
  4. Other Wet or Damp Indoor Locations: Type 4.
  5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

- B. Plenum Rating: UL 1995; NRTL certification label on enclosure, clearly identifying VFD as "Plenum Rated."

## 2.6 ACCESSORIES

- A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFD enclosure cover unless otherwise indicated.
  - 1. Push Buttons, Pilot Lights, and Selector Switches: Standard-duty.
    - a. Push Buttons: Recessed Unguarded types; momentary.
    - b. Pilot Lights: LED types; push to test.
    - c. Selector Switches: Rotary type.
- B. Reversible NC/NO bypass contactor auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Under-voltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable under-voltage, overvoltage, and time-delay settings.
  - 1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

## 2.7 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect VFDs according to requirements in NEMA ICS 61800-2.
  - 1. Test each VFD while connected to a motor that is comparable to that for which the VFD is rated.
  - 2. Verification of Performance: Rate VFDs according to operation of functions and features specified.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine areas, surfaces, and substrates to receive VFDs, with Installer present, for compliance with requirements for installation tolerances, and other conditions affecting performance.
- B. Examine VFD before installation. Reject VFDs that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 HARMONIC ANALYSIS STUDY

- A. Perform a harmonic analysis study to identify the effects of nonlinear loads and their associated harmonic contributions on the voltages and currents throughout the electrical system. Analyze operating scenarios, including recommendations for VFC input filtering to limit TDD and THD(V) at each VFC to specified levels.
- B. Prepare a harmonic analysis study and report complying with IEEE 399 and NETA Acceptance Testing Specification.

### 3.3 INSTALLATION

- A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Wall-Mounting Controllers: Install VFDs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks.
- C. Install fuses in each fusible-switch VFD.
- D. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."
- E. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.
- F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- G. Comply with NECA 1.

### 3.4 IDENTIFICATION

- A. Identify VFDs, components, and control wiring.
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each VFD with engraved nameplate.
  - 3. Label each enclosure-mounted control and pilot device.

### 3.5 CONTROL WIRING INSTALLATION

- A. Install wiring between VFDs and remote devices and facility's central-control system.
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic control devices where applicable.
  - 1. Connect selector switches to bypass only those manual- and automatic control devices that have no safety functions when switches are in manual-control position.
  - 2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### 3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each VFD element, bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- D. Tests and Inspections:
  - 1. Inspect VFD, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
  - 2. Test insulation resistance for each VFD element, component, connecting motor supply, feeder, and control circuits.
  - 3. Test continuity of each circuit.
  - 4. Verify that voltages at VFD locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
  - 5. Test each motor for proper phase rotation.
  - 6. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 7. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- E. VFDs will be considered defective if they do not pass tests and inspections.

- F. Prepare test and inspection reports. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

### 3.7 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.

### 3.8 ADJUSTING

- A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
- C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Construction Manager before increasing settings.
- D. Set the taps on reduced-voltage autotransformer controllers.

### 3.9 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.
- B. Replace VFDs whose interiors have been exposed to water or other liquids prior to Substantial Completion.

### 3.10 DEMONSTRATION

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

END OF SECTION



## SECTION 230529 - SUPPORTS AND SLEEVES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Perform all Work required to provide and install supports, hangers, anchors, sleeves and bases for all pipe, duct, equipment, system components and accessories, indicated by the Contract Documents with all supplementary items necessary for complete, code compliant and approved installation.

#### 1.2 REFERENCE STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:
  - 1. International Mechanical Code.
  - 2. International Plumbing Code.
  - 3. International Fuel Gas Code.
  - 4. ASME B31.2 - Fuel Gas Piping.
  - 5. ASME B31.9 - Building Services Piping.
  - 6. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
  - 7. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
  - 8. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
  - 9. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
  - 10. MSS SP-90 - Guidelines on Terminology for Pipe Hangers and Supports.
  - 11. NFPA 13 - Installation of Sprinkler Systems.
  - 12. NFPA 14 - Installation of Standpipe and Hose Systems.
  - 13. NFPA 99 - Standard for Health Care Facilities.
  - 14. UL 203 - Pipe Hanger Equipment for Fire Protection Service.
  - 15. SMACNA - HVAC Duct Construction Standards.
  - 16. Underwriters Laboratories Standards and Listings.

#### 1.3 QUALITY ASSURANCE

- A. Materials and application of pipe hangers and supports shall be in accordance with MSS-SP-58 and SP-69 unless noted otherwise.

- B. Support and sleeve materials and installation shall not interfere with the proper functioning of equipment.
- C. Contractor shall be responsible for structural integrity of all hangers, supports, anchors, guides, inserts and sleeves. All structural hanging materials shall have a minimum safety factor of five.
- D. Installer Qualifications: Utilize an installer experienced in performing Work of this Section who is experienced in installation of Work similar to that required for this Project and per the minimum requirements of MSS SP-89. Field welding of supports shall be by certified welders qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX using welding procedures per the minimum requirements of MSS SP-58.

#### 1.4 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog data including code compliance, load capacity, and intended application.
- B. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.
- C. Shop Drawings: Submit detailed Drawings of all shop or field fabricated supports, anchors and sleeves, signed and sealed by a qualified State of New York registered professional engineer. Indicate size and characteristics of components and fabrication details and all loads exceeding 750 pounds imposed on the base building structure.

#### 1.5 Delivery, Storage and Handling

- A. Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Maintain in place until installation.
- C. Store materials protected from exposure to harmful weather conditions.

### PART 2 PRODUCTS

#### 2.1 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

## 2.2 MANUFACTURERS

- A. Hangers and Supports:
1. Anvil International.
  2. Kinder.
  3. Cooper B-Line.
  4. C & S Mfg. Corp.
  5. Hubbard Enterprises/Holdrite
  6. National Pipe Hanger Corporation.
  7. Power Strut.

## 2.3 HANGERS AND SUPPORTS

- A. General:
1. Refer to individual system and equipment Specification Sections for additional support requirements. Comply with MSS SP-69 for support selections and applications that are not addressed within these Specifications.
  2. Utilize hangers and supports to support systems under all conditions of operation, allowing free expansion and contraction, and to prevent excessive stresses from being introduced into the structure, piping or connected equipment.
  3. All pipe supports shall be of the type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.
  4. Design hangers to impede disengagement by movement of supported pipe.
  5. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping.
  6. Wire or perforated strap iron will not be acceptable as hanger material.
  7. Hanger rods shall be threaded on both ends, threaded one end, or continuous threaded, complete with adjusting and lock nuts.
  8. Fasteners requiring explosive powder (shooting) or pneumatic-driven actuation will not be acceptable under any circumstances.
  9. Plastic anchors or plastic expansion shields will not be permitted under any circumstances.
  10. Hangers and clamps supporting and contacting individual non-insulated brass or copper lines shall be copper or copper plated. Where non-insulated brass or copper lines are supported on trapeze hangers or channels, the pipes shall be isolated from these supports with approved flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp. Plastic tape is not acceptable.

11. Hangers and clamps supporting and contacting glass piping shall be in accordance with the piping manufacturer's published recommendations and shall be fully lined with minimum 1/4 inch neoprene padding. The padding material and the configuration of its installation shall be submitted for approval.
  12. Hangers and clamps supporting and contacting plastic piping shall be in accordance with the piping manufacturer's published recommendations and shall be factory coated or padded to prevent damage to piping.
  13. Field fabricated supports shall be constructed from ASTM A36/A36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.
- B. Finishes: All ferrous hangers, rods, inserts, clamps, stanchions, and brackets on piping within interior non-corrosive environments, shall be dipped in Zinc Chromate Primer before installation. Rods may be galvanized or cadmium plated after threading, in lieu of dipping zinc chromate. All hangers and supports exposed to the weather, including roofs and building crawl space areas, shall be galvanized or manufactured from materials that will not rust or corrode due to moisture. All hangers and supports located within corrosive environments shall be constructed from or coated with materials manufactured for installation within the particular environment.
- C. Vertical Piping:
1. Supports for vertical riser piping in concealed areas shall utilize double bolt riser clamps, with each end having equal bearing on the building structure at each floor level.
  2. Supports for vertical riser piping at floor levels in exposed areas (such as fire protection standpipe in stairwells) shall be attached to the underside of the penetrated structure utilizing drilled anchors, two hanger rods (sized as specified), and socket clamp with washers.
  3. Two-hole rigid pipe clamps or four-hole socket clamps with washers may be used to support pipe directly from adequate structural members where floor-to-floor distance exceeds required vertical support spacing and lines are not subject to expansion and contraction.
- D. Trapezes: Where multiple lines are run horizontally at the same elevation and grade, they may be supported on manufactured channel, suspended on rods or pipes. Trapeze members including suspension rods shall be properly sized for the quantity, diameters, and loaded weight of the lines they are to support.
- E. Ductwork: All ductwork shall be supported in accordance with SMACNA recommendations for the service involved. Horizontal ducts supported using galvanized steel bands shall extend up both sides and onto the construction above, where they shall turn over and be secured with bolts and nuts fitted in inserts set in the concrete, bolted to angles secured to the construction above, or secured in another approved manner.
- F. Terminal Units:

1. Terminal units weighing up to 150 pounds shall be supported by four (4) 1 inch wide sheet metal straps with ends turned under bottom of unit at corners.
2. Each band shall be secured by not over 3/4 inch in length, 1/4-inch diameter sheet metal screws – two (2) on bottom of unit and one (1) on each side.
3. The other strap end shall be attached to the structure by 1/4-inch diameter threaded bolt into the concrete insert or into drilled-hole threaded concrete expansion anchor.
4. Where interference occurs, overhead of the box, not allowing direct vertical support by straps, provide trapeze channels suspended by 1/4-inch diameter galvanized threaded rods providing such channels do not block access panels of units.
5. Terminal units weighing more than 150 pounds shall be supported per the terminal unit manufacturer's installation instructions using threaded rod and hanger brackets located per manufacturer's drawing.

G. Fixture and Equipment Service Piping:

1. Piping at local connections to plumbing fixtures and equipment shall be supported to prevent the weight of the piping from being transmitted to fixtures and equipment.
2. Makeshift, field-devised methods of plumbing pipe support, such as with the use of scrap framing materials, are not allowed. Support and positioning of piping shall be by means of engineered methods that comply with IAPMO PS 42-96. These shall be Hubbard Enterprises/Holdrite support systems, C & S Mfg. Corp. or Owner-approved equivalent.
3. Supports within chases and partitions shall be corrosion resistant metal plate, clamps, angles or channels, and aligned with structure in the vertical or horizontal position. Plastic supports are not allowed unless approved by Owner.
4. Horizontal supports within chases and partitions that are attached to studs shall be attached at both ends. Drywall shall not be relied upon to support the piping.
5. Supports for plumbing fixture water service piping within chases and partitions may be attached to cast iron drain and vent pipe with approved brackets and pipe clamps.
6. Piping exposed on the face of drywall shall be supported with corrosion resistant metal channels that are attached to wall studs. Drywall shall not be relied upon to support the piping.
7. Piping supported from the floor shall utilize corrosion resistant metal channels or brackets that are anchored to the floor slab.
8. All water piping shall be isolated from building components to prevent the transmission of sound.
9. All copper or brass lines shall be isolated from ferrous metals with dielectric materials to prevent electrolytic action. Plastic tape is not an acceptable isolation material.

H. Inserts:

1. Cast-in-place concrete inserts shall comply with MSS-SP-69, U.L. and F.M. approved, and sized to suit threaded hanger rods.
  2. Inserts shall have malleable iron case with galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods. Suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction. If the inserts are later found not to be in the proper location for the placement of hangers, then drilled anchors shall be installed. Drilled anchors in concrete or masonry shall be submitted for the approval.
  3. Manufactured inserts for metal deck construction shall have legs custom fit to rest in form valleys.
  4. Shop fabricated inserts shall be submitted and approved by Owner prior to installation.
  5. Inserts shall be of a type that will not interfere with structural reinforcing and that will not displace excessive amounts of structural concrete.
- I. Pipe Shields: Provide pipe shields in accordance with insulation manufacturer's published recommendations. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier.
- J. Concrete Pads and Equipment Bases:
1. Coordinate sizes and locations of concrete bases with actual equipment provided.
  2. Construct concrete bases 4 inches high unless otherwise indicated; and extend base not less than 6 inches in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
  3. Minimum Compressive Strength: 3000 psi at 28 days.
  4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
  5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor them into structural concrete substrate.
  6. Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  7. Cast anchor-bolt insert into bases. Install anchor bolts to elevations required for proper attachment to supported equipment.
- 2.4 Pipe and duct penetrations
- A. General:

1. Seal penetrations through all rated partitions, walls and floors with U.L. tested assemblies to provide and maintain a rating equal to or greater than the partition, wall or floor.
  2. Inside diameter of all sleeves or cored holes shall provide sufficient annular space between outside diameter of pipe, duct or insulation to allow proper installation of required fire and water proofing materials and allow for movement due to expansion and contraction.
  3. Exposed ceiling, floor and wall pipe penetrations within finished areas (including exterior wall faces) shall be provided with chrome plated, brass or stamped steel, hinged, split-ring escutcheon with set screw or snap-on type. Inside diameter shall closely fit pipe outside diameter or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings. In exterior, damp, or corrosive environments, use Type 302 stainless steel escutcheons.
- B. Floor Pipe Penetrations:
1. Seal penetrations through all floors to provide and maintain a watertight installation.
  2. Sleeves cast in the slab for pipe penetrations shall be Schedule 40 steel, ASTM A53, with 2-inch-wide annular fin water-stop continuously welded at midpoint. Entire assembly shall be hot-dipped galvanized after fabrication. Water-stop shall be same thickness as sleeve.
  3. Cored holes in the slab for pipe penetrations shall be provided with a Schedule 40 steel, ASTM A53, sleeve with 2-inch-wide annular fin water-stop continuously welded at point on sleeve to allow countersinking into slab and waterproofing. Entire sleeve assembly shall be hot-dipped galvanized after fabrication. Water-stop shall be same thickness as sleeve.
  4. All sleeves shall extend a minimum of two inches above finished floor.
  5. Where job conditions prevent the use of a sleeve that extends two inches above the slab, Link-Seal mechanical casing seals manufactured by Thunderline Corporation may be installed to provide a watertight penetration. Mechanical casing seals can be used only for relatively small diameter pipe penetrations. Verify that slab thickness allows proper installation of the link-seal assembly and the required fire stopping prior to applying this exception.
- C. Wall Penetrations:
1. Where piping or ductwork passes through non-rated partition, close off space between pipe or duct and construction with gypsum wallboard and repair plaster smoothed and finished to match adjacent wall area.
  2. Pipe penetrations through interior rated partitions shall be provided with adjustable prefabricated U.L. listed fire rated galvanized sheet metal sleeves having gauge thickness as required by wall fire rating, 20-gauge minimum.  
EXCEPTION: When U.L. Listed assembly does not require a sleeve,

3. Pipe penetrations through exterior walls and walls below grade shall be provided with "Link-Seal" mechanical casing seal manufactured by Thunderline Corporation.
  4. Ductwork penetrations through rated partitions, walls and floors shall be provided with sleeves that are manufactured integral with the damper assembly installed.
- D. Flashing:
1. Coordinate flashing material and installation required for pipe and duct roof penetrations with Owner and roofing Contractor.
  2. Provide flexible flashing and metal counter-flashing where ductwork penetrates exterior walls. Seal penetration water and air tight.
  3. Provide acoustical flashing around ducts and pipes penetrating equipment rooms, with materials and installation in accordance with manufacturer's instructions for sound control.
- E. Roof Curbs: Coordinate roof curb material and installation with Owner and roofing Contractor.

### PART 3 EXECUTION

#### 3.1 Preparation

- A. Conduct a pre-installation meeting prior to commencing Work of this Section to verify Project requirements, coordinate with other trades, establish condition and completeness of substrate, review manufacturer's installation instructions and manufacturer's warranty requirements.

#### 3.2 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. Application, sizing and installation of piping, supports, anchors and sleeves shall be in accordance with manufacturer's printed installation instructions.
- C. Provide for vertical adjustments after erection and during commissioning, where feasible, to ensure pipe is at design elevation and slope.
- D. Install hangers and supports to allow controlled thermal movement of piping systems, permitting freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- E. Install hanger so that rod is vertical under operating conditions.



- F. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.
- G. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete that holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required. Contractor shall be responsible for engaging a structural engineer as required for design and review at support systems.
- H. Do not hang pipe, duct or any mechanical/plumbing item directly from a metal deck or locate on the bottom chord of any truss or joist unless approved by the Structural Engineer of Record.
- I. All supports shall be designed and installed to avoid interference with other piping, hangers, ducts, electrical conduit, supports, building structures, equipment, etc.
- J. Piping supports shall be independent from ductwork supports. Combining supports is not permitted.
- K. Provide all supporting steel required for the installation of mechanical equipment and materials, including angles, channels, beams, etc. to suspended or floor supported tanks and equipment. All of this steel may not be specifically indicated on the Drawings.
- L. All piping and ductwork supports shall be designed and installed to allow the insulation to be continuous through the hangers.
- M. Adjustable clevis hangers shall be supported at rods with a nut above and below the hanger.
- N. All hanger rods shall be trimmed neatly so that 1 inch of excess hanger rod protrudes beyond the hanger nut. In the event a rod is intentionally but temporarily left excessively long (for sloped or insulated lines for example), the Contractor shall take appropriate measures to protect the pipe or other materials from damage.
- O. Install hangers to provide minimum ½ inch space between finished covering and adjacent structures, materials, etc.
- P. Horizontal and vertical piping in chases and partitions shall be supported to prevent movement and isolated from the supports to prevent transmission of sound.
- Q. Locate hangers within 12 inches of each horizontal elbow.
- R. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- S. Support riser piping independently of connected horizontal piping. Riser piping is defined as vertical piping extending through more than one floor level.

- T. Support riser piping at each floor level and provide additional supports where floor-to-floor distance exceeds required vertical support spacing. Installation of riser clamps and welded steel riser supports shall not allow weight of piping to be transmitted to floor sleeves.
- U. Steel Bar Joists: Hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded or otherwise permanently fixed to the top of joists.
- V. Steel Beams: Where pipes and loads are supported under steel beams, approved type beam clamps shall be used.
- W. Pre-Cast Tee Structural Concrete: Hanger supports, anchors, etc. attached to the precast, double tee, structural concrete system shall be installed in accordance with approved Shop Drawings only. Holes required for hanger rods shall be core drilled in the "flange" of the double tee only; impact type tools are not allowed under any circumstances. Core drilling in the "stem" portions of the double tee is not allowed. Holes core drilled through the "flange" for hanger rods shall be no greater than 1/4 inch larger than the diameter of the hanger rod. Hanger rods shall supported by means of bearing plates of size and shape acceptable to the Architect/Engineer, with welded double nuts on the hanger rod above the bearing plate. Cinch anchors, lead shields, expansion bolts, and studs driven by explosion charges are not allowed under any circumstances in the lower 15 inches of each stem and in the "shadow" of the stem on the top side of the "double tees".
- X. 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.
- Y. Inserts:
  - 1. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - 2. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  - 3. Install anchors in concrete after concrete is placed and completely cured. Install anchors according to manufacturer's written instructions..
- Z. Flashing:
  - 1. Coordinate all roof flashing with requirements of Division 07.
- AA. Pipe Shields:
  - 1. Provide shields at each hanger supporting insulated pipe.
  - 2. Provide shields of the proper length to distribute weight evenly and to prevent compression of insulation at hanger.

3. Install shield so that hanger is located at the center of the shield.
4. Attach shield to insulation with adhesive to prevent slippage or movement.

BB. Equipment Anchor Bolts:

1. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt shall be set in a sleeve of sufficient size to provide ½ inch clearance around bolt.

END OF SECTION 230529

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## SECTION 230548 - VIBRATION CONTROLS FOR HVAC

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Elastomeric isolation pads.
  - 2. Elastomeric isolation mounts.
  - 3. Restrained elastomeric isolation mounts.
  - 4. Open-spring isolators.
  - 5. Restrained-spring isolators.
  - 6. Pipe-riser resilient supports.
  - 7. Resilient pipe guides.
  - 8. Elastomeric hangers.
  - 9. Spring hangers.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
  - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device type required.
- B. Shop Drawings:
  - 1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
  - 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: For each vibration isolation device.
  - 1. Include design calculations for selecting vibration isolators and for designing vibration isolation bases.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For testing agency.
- C. Welding certificates.

#### 1.5 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

### PART 2 PRODUCTS

#### 2.1 ELASTOMERIC ISOLATION PADS

- A. Elastomeric Isolation Pads:
  - 1. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
  - 2. Size: Factory or field cut to match requirements of supported equipment.
  - 3. Pad Material: Oil and water resistant with elastomeric properties.
  - 4. Surface Pattern: Waffle pattern.
  - 5. Infused nonwoven cotton or synthetic fibers.
  - 6. Load-bearing metal plates adhered to pads.
  - 7. Sandwich-Core Material: Resilient and elastomeric.
    - a. Surface Pattern: Waffle pattern.
    - b. Infused nonwoven cotton or synthetic fibers.

#### 2.2 ELASTOMERIC ISOLATION MOUNTS

- A. Double-Deflection, Elastomeric Isolation Mounts:
  - 1. Mounting Plates:
    - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
    - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
  - 2. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

#### 2.3 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

- A. Restrained Elastomeric Isolation Mounts:
  - 1. Description: All-directional isolator with restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
    - a. Housing: Cast-ductile iron or welded steel.
    - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

## 2.4 OPEN-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators:
  - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 5. Baseplates: Factory-drilled steel plate for bolting to structure with an elastomeric isolator pad attached to the underside. Baseplates shall limit floor load to 500 psig.
  - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

## 2.5 RESTRAINED-SPRING ISOLATORS

- A. Freestanding, Laterally Stable, Open-Spring Isolators with Vertical-Limit Stop Restraint:
  - 1. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
    - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
    - b. Top plate with elastomeric pad.
    - c. Internal leveling bolt that acts as blocking during installation.
  - 2. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
  - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

## 2.6 PIPE-RISER RESILIENT SUPPORT

- A. Description: All-directional, acoustical pipe anchor consisting of two steel tubes separated by a minimum 1/2-inch- thick neoprene.
  - 1. Vertical-Limit Stops: Steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions.
  - 2. Maximum Load Per Support: 500 psig on isolation material providing equal isolation in all directions.

## 2.7 RESILIENT PIPE GUIDES

- A. Description: Telescopic arrangement of two steel tubes or post and sleeve arrangement separated by a minimum 1/2-inch-thick neoprene
  - 1. Factory-Set Height Guide with Shear Pin: Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

## 2.8 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods:
  - 1. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
  - 2. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

## 2.9 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression:
  - 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
  - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
  - 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.



8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 VIBRATION CONTROL DEVICE INSTALLATION

- A. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.

END OF SECTION

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## SECTION 230553 - MECHANICAL IDENTIFICATION

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Pipe labels.
  - 3. Duct labels.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

#### 1.3 COORDINATION

- A. Coordinate installation of identifying devices with locations of access panels and doors.
- B. Install identifying devices before ceilings are installed.

### PART 2 PRODUCTS

#### 2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
  - 1. Material and Thickness: Stainless steel, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  - 3. 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.
  - 4. Fasteners: Stainless-steel self-tapping screws.
- B. Plastic Labels for Equipment:
  - 1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
  - 2. Letter Color: White.

3. Background Color: Black.
  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. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- C. Label Content: Include equipment designation or tag number and service. Provide additional information where indicated or requested by Owner/Engineer.
- D. Equipment Label Schedule: Include schedule in IOM manual.

## 2.2 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  2. Length: 12" for piping less than or equal to 4" NPS, 24" for piping greater than 4" NPS.
  3. Lettering Size: 1.25" for piping less than or equal to 4" NPS, 24" for piping greater than 4" NPS.
- D. Pipe Label Color Schedule:
1. Chilled-Water Piping: Blue background with white lettering.
  2. Condenser-Water Piping: Green background with white lettering.
  3. Heating Hot Water Piping: Yellow background with black lettering.

## 2.3 DUCT LABELS

- A. Stencils: Minimum letter height of 3 inches.
1. Stencil Material: Fiberboard or metal.
  2. Stencil Paint: Exterior, gloss, acrylic enamel, black unless otherwise indicated. Paint may be in pressurized spray-can form.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Clean 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. 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 25 feet along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.
  - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

### 3.4 DUCT LABEL INSTALLATION

- A. Stenciled labels, showing service and flow direction, increase lettering size where needed for proper identification because of distance from normal location of required identification.
- B. Locate labels in mechanical equipment rooms near points where ducts penetrate walls or enter into concealed spaces and at maximum intervals of 20 feet or as required to properly identify ductwork.

END OF SECTION

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## SECTION 230593 - TESTING, ADJUSTING, AND BALANCING

### PART 1 GENERAL

#### 1.1 SCOPE OF WORK

- A. All new and existing equipment shown on plans shall be included unless otherwise noted.
- B. Provide testing, adjusting and balancing (TAB) for the following:
  - 1. Air Side Equipment: All air moving equipment including ductwork, air terminals and air inlets/outlets.
  - 2. Hydronic Equipment: Pumps, piping systems, coils and heating terminals.

#### 1.2 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. MC: Mechanical Contractor.
- C. NEBB: National Environmental Balancing Bureau.
- D. TAB: Testing, adjusting, and balancing.

#### 1.3 SUBMITTALS

- A. Qualification Data: AABC or NEBB certification.
- B. Written statement of coordination with sheetmetal contractor.
- C. Written statement of coordination with piping contractor.
- D. Written statement of acceptance of location and quantity of air and water balancing devices.
- E. Final TAB reports.

#### 1.4 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB contractor certified by AABC or NEBB.
- B. TAB Procedures: Employ procedures and test methods published by AABC, NEBB or ASHRAE.

#### 1.5 general requirements

- A. TAB Contractor Qualifications: Engage a TAB contractor certified by AABC or NEBB.

## PART 2 PRODUCTS (NOT APPLICABLE)

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements. Notify Engineer of any questions regarding balancing within 45 days of MC notice to proceed.
- B. TAB Contractor shall review ductwork shop drawings and mark locations of all required volume dampers prior to fabrication.
  - 1. Submit documentation of coordination with sheetmetal contractor.
  - 2. Documentation shall include electronic copies of ductwork shop drawings including dates, names and signatures of each party.
- C. TAB Contractor shall review piping drawings and mark locations of all required balancing devices prior to fabrication.
  - 1. Submit documentation of coordination with piping contractor.
  - 2. Documentation shall include electronic copies of piping plans including dates, names and signatures of each party.
- D. Examine the approved submittals for HVAC systems and equipment.
- E. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- F. Examine test reports specified in individual system and equipment Sections.
- G. 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.
- H. Examine terminal units, such as variable-air-volume boxes, and verify that they are accessible, and their controls are connected and functioning.
- I. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- J. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- 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. Automatic temperature-control systems are operational.
  - 3. Equipment and duct access doors are securely closed.
  - 4. Balance, smoke, and fire dampers are open.
  - 5. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  - 6. 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" and in this Section.
  - 1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
  - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
  - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."
  - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC 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.

### 3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. For variable-air-volume systems, develop a plan to simulate diversity.
- D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- G. Verify that motor starters are equipped with properly sized thermal protection.
- H. Check dampers for proper position to achieve desired airflow path.
- I. Check for airflow blockages.
- J. Check condensate drains for proper connections and functioning.
- K. Check for proper sealing of air-handling-unit components.
- L. Verify that air duct system is sealed as specified in Division 23 Section "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 Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 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 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

- A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a minimum set-point airflow with the remainder at maximum-airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced-airflow terminal units so they are distributed evenly among the branch ducts.
- B. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
  - 1. Set outdoor-air dampers at minimum, and set return- and exhaust-air dampers at a position that simulates full-cooling load.
  - 2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
  - 3. Measure total system airflow. Adjust to within indicated airflow.
  - 4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units the same as described for constant-volume air systems.
  - 5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow the same as described for constant-volume air systems.
    - a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
  - 6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outdoor airflow.
    - a. Adjust the fan and balance the return-air ducts and inlets the same as described for constant-volume air systems.
  - 7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
  - 8. Record final fan-performance data.

### 3.7 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Balance air systems prior to hydronic system balancing.
- B. 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.
- C. Prepare schematic diagrams of systems' "as-built" piping layouts.

- D. System shall be cleaned and treated prior to hydronic system balancing.
- E. 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 expansion tank(s) for proper operation and air pressure. Record air charge pressure prior to start-up and again when system reaches normal operating temperatures/pressures.
  - 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
  - 4. Set system controls so automatic valves are wide open.
  - 5. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
  - 6. Check all air vents and determine if the system has been properly vented and is ready for testing.
  - 7. Clean strainers. Install final strainers where indicated.
- F. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.
- G. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
- H. Set calibrated balancing valves, if installed, at calculated presettings.
- I. 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.
- J. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- K. 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.
- L. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
- M. Check settings and operation of each safety valve. Record settings.

### 3.8 PROCEDURES FOR pumps

- 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.
  - 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 pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures.

### 3.9 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.

### 3.10 PROCEDURES FOR HEAT-TRANSFER COILS

- A. Measure, adjust, and record the following data for each water coil:
  - 1. Entering- and leaving-water temperature.
  - 2. Water flow rate.
  - 3. Water pressure drop.

4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.11 PROCEDURES FOR TESTING, ADJUSTING, AND BALANCING EXISTING SYSTEMS

- A. Perform a preconstruction inspection of existing equipment that is to remain and be reused.
1. Measure and record the operating speed, airflow, and static pressure of each fan.
  2. Measure motor voltage and amperage. Compare the values to motor nameplate information.
  3. Check the refrigerant charge.
  4. Check the condition of filters.
  5. Check the condition of coils.
  6. Check the operation of the drain pan and condensate-drain trap.
  7. Check bearings and other lubricated parts for proper lubrication.
  8. Report on the operating condition of the equipment and the results of the measurements taken. Report deficiencies.
- B. Before performing testing and balancing of existing systems, inspect existing equipment that is to remain and be reused to verify that existing equipment has been cleaned and refurbished. Verify the following:
1. New filters are installed.
  2. Coils are clean and fins combed.
  3. Drain pans are clean.
  4. Fans are clean.
  5. Bearings and other parts are properly lubricated.
  6. Deficiencies noted in the preconstruction report are corrected.
- C. Perform testing and balancing of existing systems to the extent that existing systems are affected by the renovation work.
1. Compare the indicated airflow of the renovated work to the measured fan airflows, and determine the new fan speed and the face velocity of filters and coils.

2. Verify that the indicated airflows of the renovated work result in filter and coil face velocities and fan speeds that are within the acceptable limits defined by equipment manufacturer.
3. If calculations increase or decrease the air flow rates and water flow rates by more than 5 percent, make equipment adjustments to achieve the calculated rates. If increase or decrease is 5 percent or less, equipment adjustments are not required.
4. Balance each air outlet.

### 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.
  4. Cooling-Water Flow Rate: Plus or minus 10 percent.

### 3.13 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

### 3.14 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
  1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
  1. Pump curves.
  2. Fan curves.
  3. Manufacturers' test data.



4. Field test reports prepared by system and equipment installers.
  5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
  2. Name and address of the TAB contractor.
  3. Project name.
  4. Project location.
  5. Architect's name and address.
  6. Engineer's name and address.
  7. Contractor's name and address.
  8. Report date.
  9. Signature of TAB supervisor who certifies the report.
  10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  11. Summary of contents including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  12. Nomenclature sheets for each item of equipment.
  13. Data for terminal units, including manufacturer's name, type, size, and fittings.
  14. Notes to explain why certain final data in the body of reports vary from indicated values.
  15. Test conditions for fans and pump performance forms including the following:
    - a. Settings for outdoor-, return-, and exhaust-air dampers.
    - b. Conditions of filters.
    - c. Cooling coil, wet- and dry-bulb conditions.
    - d. Face and bypass damper settings at coils.
    - e. Fan drive settings including settings and percentage of maximum pitch diameter.
    - f. Inlet vane settings for variable-air-volume systems.
    - g. Settings for supply-air, static-pressure controller.
    - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
  2. Water and steam flow rates.
  3. Duct, outlet, and inlet sizes.
  4. Pipe and valve sizes and locations.
  5. Terminal units.

6. Balancing stations.
  7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and unit size.
    - e. Manufacturer's serial number.
    - f. Unit arrangement and class.
    - g. Discharge arrangement.
    - h. Sheave make, size in inches, and bore.
    - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    - j. Number, make, and size of belts.
    - k. Number, type, and size of filters.
  2. Motor Data:
    - a. Motor make, and frame type and size.
    - b. Horsepower and rpm.
    - c. Volts, phase, and hertz.
    - d. Full-load amperage and service factor.
    - e. Sheave make, size in inches, and bore.
    - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
  3. Test Data (Indicated and Actual Values):
    - a. Total air flow rate in cfm.
    - b. Total system static pressure in inches wg.
    - c. Fan rpm.
    - d. Discharge static pressure in inches wg.
    - e. Filter static-pressure differential in inches wg.
    - f. Preheat-coil static-pressure differential in inches wg.
    - g. Cooling-coil static-pressure differential in inches wg.
    - h. Heating-coil static-pressure differential in inches wg.
    - i. Outdoor airflow in cfm.
    - j. Return airflow in cfm.
    - k. Outdoor-air damper position.
    - l. Return-air damper position.
    - m. Vortex damper position.
- F. Apparatus-Coil Test Reports:
1. Coil Data:
    - a. System identification.

- b. Location.
    - c. Coil type.
    - d. Number of rows.
    - e. Fin spacing in fins per inch 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.
- G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
- 1. Fan Data:
    - a. System identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and size.
    - e. Manufacturer's serial number.
    - f. Arrangement and class.
    - g. Sheave make, size in inches, 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.
  - H. Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
    - 1. Report Data:
      - a. System and air-handling-unit number.
      - b. Location and zone.
      - c. Traverse air temperature in deg F.
      - d. Duct static pressure in inches wg.
      - e. Duct size in inches.
      - f. Duct area in sq. ft..
      - g. Indicated air flow rate in cfm.
      - h. Indicated velocity in fpm.
      - i. Actual air flow rate in cfm.
      - j. Actual average velocity in fpm.
      - k. Barometric pressure in psig.
  - I. Air-Terminal-Device Reports:
    - 1. Unit Data:
      - a. System and air-handling unit identification.
      - b. Location and zone.
      - c. Apparatus used for test.
      - d. Area served.
      - e. Make.
      - f. Number from system diagram.
      - g. Type and model number.
      - h. Size.
      - i. Effective area in sq. ft..
    - 2. Test Data (Indicated and Actual Values):
      - a. Air flow rate in cfm.
      - b. Air velocity in fpm.
      - c. Preliminary air flow rate as needed in cfm.
      - d. Preliminary velocity as needed in fpm.
      - e. Final air flow rate in cfm.
      - f. Final velocity in fpm.

- g. Space temperature in deg F.
- J. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
  - 1. Unit Data:
    - a. System and air-handling-unit identification.
    - b. Location and zone.
    - c. Room or riser served.
    - d. Coil make and size.
    - e. Flowmeter type.
  - 2. Test Data (Indicated and Actual Values):
    - a. Air flow rate in cfm.
    - b. Entering-water temperature in deg F.
    - c. Leaving-water temperature in deg F.
    - d. Water pressure drop in feet of head or psig.
    - e. Entering-air temperature in deg F.
    - f. Leaving-air temperature in deg F.
- K. Instrument Calibration Reports:
  - 1. Report Data:
    - a. Instrument type and make.
    - b. Serial number.
    - c. Application.
    - d. Dates of use.
    - e. Dates of calibration.

### 3.15 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 the Engineer.

2. Engineer 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.
  3. 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."
  4. 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.

### 3.16 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION

## SECTION 230713 - DUCT INSULATION

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes insulating the following interior ductwork.
  - 1. Supply and return air ductwork (except where noted).
  - 2. Outdoor air ductwork.
  - 3. Exhaust air ductwork (3 feet from penetration of building exterior).
  - 4. Exterior ductwork.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
  - 1. Include insulation schedule indicating applications and methods of compliance with specified performance.

#### 1.3 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

#### 1.4 COORDINATION

- A. 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.

#### 1.5 DEFINITIONS

- A. Concealed: Located above ceilings or in chases, shafts or soffits.

- B. Exposed: Where visible when construction and finishes are complete including mechanical rooms, storage areas, and spaces without ceilings.

## 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.

## PART 2 PRODUCTS

### 2.1 DUCT AND PLENUM INSULATION SCHEDULE

- A. Supply and return air ductwork.
  - 1. Concealed Locations: Mineral-Fiber Blanket; R-6.
  - 2. Exposed Locations: Mineral-Fiber Board; R-6.
  - 3. Exception: Supply and return air ductwork exposed to view in conditioned spaces served by ductwork shall not be insulated.
- B. Outdoor air ductwork and plenums.
  - 1. Concealed Locations: Mineral-Fiber Blanket; R-12
  - 2. Exposed Locations: Mineral-Fiber Board; R-12
- C. Exhaust air ductwork and plenums (3 feet from penetration of building exterior or isolation damper, whichever is longer).
  - 1. Concealed Locations: Mineral-Fiber Blanket; R-12
  - 2. Exposed Locations: Mineral-Fiber Board; R-12
- D. Exterior ductwork.
  - 1. Mineral-Fiber Board with Field Applied Jacketing; R-12.
- E. Items Not Insulated:
  - 1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
  - 2. Factory-insulated flexible ducts.
  - 3. Factory-insulated plenums and casings.
  - 4. Flexible connectors.
  - 5. Vibration-control devices.
  - 6. Factory-insulated access panels and doors.

### 2.2 INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.



- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following. No substitutions will be permitted without written approval prior to receipt of bids:
  - 1. CertainTeed Corp.
  - 2. Johns Manville.
  - 3. Knauf Insulation.
  - 4. Manson Insulation Products Ltd.
- C. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553.
  - 1. FSK Jacket: Factory applied aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
  - 2. Provide density and thickness as required to meet R-Values specified in the Insulation Schedule. R-Values shall be Installed at 25% compression.
- D. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB, with factory-applied FSK jacket.
  - 1. FSK Jacket: Factory applied aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
  - 2. Provide density and thickness as required to meet R-Values specified in the Insulation Schedule.

## 2.3 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, provide one of 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.

## 2.4 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
  - 1. 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. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.
  - b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
  - c. Vimasco Corporation; 713 and 714.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0 to 180 deg F.
5. Color: White.

## 2.5 FIELD-APPLIED JACKETS

- A. Self-Adhesive Outdoor Jacket: 60-mil- thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with stucco embossed aluminum-foil facing.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Polyguard Products, Inc.; Alumaguard 60.
    - b. VentureCladPlus 1579GCW-E

## 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 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.
- C. Keep insulation materials dry during application and finishing.
- D. Install insulation with least number of joints practical.
- E. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

### 3.4 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations.  
Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

END OF SECTION 230713

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## SECTION 230719 - PIPE INSULATION

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes insulating the following mechanical piping systems:
  - 1. Condensate drain piping.
  - 2. Heating hot-water piping.
  - 3. Refrigerant piping.
  - 4. Chilled-water and brine piping, indoors and outdoors.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
  - 1. Include insulation schedule indicating applications and methods of compliance with specified performance.

#### 1.3 COORDINATION

- A. 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.

#### 1.4 SCHEDULING

- A. Schedule insulation application after pressure and leak testing systems. Insulation application may begin on segments that have satisfactory test results.
  - 1. QUALITY ASSURANCE
    - a. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing 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.
  - 2. DELIVERY, STORAGE, AND HANDLING

- B. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

## PART 2 PRODUCTS

### 2.1 pipe INSULATION schedule

- A. Heating Hot Water Piping: Insulation Type A.
  - 1. Pipe Sizes less than 1.5 NPS: 1.5-inches thick.
  - 2. Pipe Sizes 1.5 NPS and larger: 2-inches thick.
  - 3. Pre-Molded PVC Fitting Covers; Zeston or equal.
  - 4. Provide high impact strength PVC pipe jacketing for piping exposed in finished spaces.
- B. Condensate Drainage Piping: Insulation Type B.
  - 1. All Pipe Sizes: 0.5-inches thick.
  - 2. Provide manufacturer recommended insulation adhesive for all joints. Seal butt joints with approved tape system.
- C. Refrigerant Piping: Insulation Type B.
  - 1. Pipe Sizes less than 1.5 NTS: 1.0-inches thick.
  - 2. Pipe Sizes 1.5 NTS and larger: 1.5-inches thick.
  - 3. Provide manufacturer recommended insulation adhesive for all joints. Seal butt joints with approved tape system.
  - 4. Provide high impact strength PVC pipe jacketing for exterior piping.
    - a. Chilled Water and Brine, above 40 Deg F: Insulation Type C.
      - 1) NPS 12 and Smaller: Insulation shall be the following:
        - a) Cellular Glass: 2 inches thick.
    - b. Chilled Water and Brine: Insulation Type C.
      - 1) All Pipe Sizes: Insulation shall be the following:
        - a) Cellular Glass: 3 inches thick.

### 2.2 PIPE INSULATION MATERIALS

- A. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following. No substitutions will be permitted without written approval prior to receipt of bids:
  - 1. CertainTeed Corp.
  - 2. Johns Manville.
  - 3. Knauf Insulation.

4. Manson Insulation Products Ltd.
  5. Armacell, LLC.
- C. Pipe insulating materials shall be as follows:
1. Type A: Fiberglass pipe insulation jacketed with a reinforced white all service vapor retarder jacket (ASJ) and factory applied longitudinal acrylic adhesive closure system. UL rated for maximum flamespread 25 and smoke developed 50.
    - a. Thermal Conductivity: 0.23 (Btu-in./h-sf) at 75F mean temperature.
  2. Type B: Closed Cell Foam Pipe Insulation. Pre-slit foamed plastic pipe insulation, rated for maximum flame spread 25 and smoke developed 50, with slit positioned at side and vapor sealed with adhesive on all joints.
    - a. Thermal Conductivity: 0.28 (Btu-in./h-sf) at 75F mean temperature and 1.5-inch wall thickness.
    - b. AP Armaflex Black LapSeal or approved equal.
  3. Type C: Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
    - a. Block Insulation: ASTM C 552, Type I.
    - b. Special-Shaped Insulation: ASTM C 552, Type III.
    - c. Board Insulation: ASTM C 552, Type IV.
    - d. If retaining both types of insulation in first two subparagraphs below, indicate where each type applies in insulation system schedules.
    - e. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
    - f. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
    - g. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- D. High Impact Strength Jacketing: Furnish PVC jacketing and fitting covers, conforming to ASTM E-84; flame spread 25, smoke developed 50, white high gloss finish, 0.02" minimum thickness.
- E. Furnish pre-molded PVC jacketing and fitting covers, lo-smoke type, as manufactured by Proto Corp.; or an approved equal.
1. PVC: Conform with FS L-P-535C, Composition A, Type II, Grade GU.
  2. Fiberglass: Conform with FS HH-I-558C, Form B, Type I, Class 7&8.
  3. Subject to compliance with requirements, provide one of the following :
    - a. [Johns Manville](#); Zeston.
    - b. [Proto Corporation](#); LoSmoke.
    - c. [Speedline Corporation](#); SmokeSafe.
  4. 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. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
- 5. MASTICS
  - a. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
  - b. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
    - 1) Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
    - 2) Service Temperature Range: Minus 20 to plus 180 deg F.
    - 3) Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
    - 4) Color: White.
  - c. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
    - 1) Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
    - 2) Service Temperature Range: Minus 50 to plus 220 deg F.
    - 3) Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
    - 4) Color: White.
- 6. SEALANTS
  - a. Cellular-Glass, Phenolic, and Polyisocyanurate Joint Sealants.
  - b. FSK and Metal Jacket Flashing Sealants:
    - 1) Materials shall be compatible with insulation materials, jackets, and substrates.
    - 2) Fire- and water-resistant, flexible, elastomeric sealant.
    - 3) Service Temperature Range: Minus 40 to plus 250 deg F.
    - 4) Color: Aluminum.
- 7. FIELD-APPLIED JACKETS
  - a. Metal Jacket:
    - 1) Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
      - a) Factory cut and rolled to size.
      - b) Finish and thickness are indicated in field-applied jacket schedules.
      - c) Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper
      - 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) Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
    - a) Factory cut and rolled to size.
    - b) Material, finish, and thickness are indicated in field-applied jacket schedules.
    - c) Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper
    - 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.
8. TAPES
  - a. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
    - 1) Width: 2 inches.
    - 2) Thickness: 3.7 mils.
    - 3) Adhesion: 100 ounces force/inch in width.
    - 4) Elongation: 5 percent.
    - 5) Tensile Strength: 34 lbf/inch in width.
9. SECUREMENTS
  - a. Bands:
    - 1) 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 or closed seal.
    - 2) 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 INSTALLATION, GENERAL

A. Comply with the manufacturer's installation instructions.

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.

2. PREPARATION

- a. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- b. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
  - 1) Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- c. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- d. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

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 o.c.
  - 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 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 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.

### 3.2 PENETRATIONS

- A. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- B. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
  - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- C. Insulation Installation at Floor Penetrations:
  - 1. Pipe: Install insulation continuously through floor penetrations.
  - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."
  - 3. 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.
4. INSTALLATION OF CELLULAR-GLASS INSULATION
- a. Insulation Installation on Straight Pipes and Tubes:
    - 1) Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
    - 2) Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
    - 3) For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
    - 4) For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
  - b. Insulation Installation on Pipe Flanges:
    - 1) Install preformed pipe insulation to outer diameter of pipe flange.
    - 2) Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
    - 3) Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
    - 4) Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.
  - c. Insulation Installation on Pipe Fittings and Elbows:

- 1) Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
      - 2) When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.
    - d. Insulation Installation on Valves and Pipe Specialties:
      - 1) Install preformed sections of cellular-glass insulation to valve body.
      - 2) Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
      - 3) Install insulation to flanges as specified for flange insulation application.
  5. FIELD-APPLIED JACKET INSTALLATION
    - a. 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 o.c. and at end joints.
  6. FINISHES
    - a. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
      - 1) Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
        - a) Finish Coat Material: Interior, flat, latex-emulsion size.
    - b. 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.
- 3.3 INSTALLATION OF fiberglass INSULATION
- A. Insulation on all cold surfaces must be applied with a continuous, unbroken vapor seal. Hangers, supports, anchors, etc., that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation.
- 3.4 INSTALLATION AT HANGERS
- A. Reset and realign hangers and supports if they are displaced while installing the piping insulation.

- B. Fiberglass Insulation: Install high density insulation filler pieces, at all points of support, between pipe insulation shields and pipe or tubing not supported by an insulation shield and insulating saddle unit. Do not install high density insulation filler pieces on hot service piping 6" and larger scheduled to have steel saddles. Install filler pieces of the same thicknesses as adjoining pipe insulation x 12" length.
  - 1. Install high density molded polyurethane or high density polystyrene filler pieces.
- C. Galvanized metal shields shall be applied between hangers or supports and the pipe insulation. Shields shall be formed to fit the insulation and shall extend up to the centerline of the pipe and 8" length.
  - 1. INDOOR, FIELD-APPLIED JACKET SCHEDULE
    - a. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
    - b. If more than one material is listed, selection from materials listed is Contractor's option.
    - c. Piping, Concealed:
      - 1) Aluminum, Smooth: 0.040 inch thick.
    - d. Piping, Exposed:
      - 1) Aluminum, Smooth: 0.040 inch thick.
  - 2. OUTDOOR, FIELD-APPLIED JACKET SCHEDULE
    - a. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
    - b. If more than one material is listed, selection from materials listed is Contractor's option.
    - c. Piping, Exposed:
- D. Stainless Steel, Type 304 or 316, Smooth 2B Finish with Z-Shaped Locking Seam: 0.024 inch thick.

END OF SECTION



## SECTION 230800 - COMMISSIONING OF HVAC SYSTEMS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. The requirements of this section are supplementary to the General Commissioning Requirements for the project and do not negate or supersede the commissioning requirements specified elsewhere.
- B. This section defines the commissioning responsibilities of the Division 23 Contractor (referred to herein as either "MC" or "the Contractor") and all other subcontractors or factory-authorized service representatives responsible for the systems to be commissioned. The responsibilities of other parties, including the Commissioning Agent (CxA), Owner, and Design Team (A/E) are referenced for clarification purposes only.
- C. This section includes additional commissioning process requirements for the following HVAC systems, assemblies and equipment. This list of Systems to be Commissioned may be modified as described in 019113 "General Commissioning Requirements." The final list of Systems to be Commissioned will be included in the Commissioning Plan provided by the CxA.
  - 1. Building Automation and Temperature Control Systems.
  - 2. Condensing Boilers.
  - 3. Boilers, Burners and Controls.
  - 4. HVAC Pumps.
  - 5. Hydronic Radiant Floor Heating Systems.
  - 6. Ducted Heating Coils.
  - 7. Unit Ventilators.
  - 8. Unit Heaters and Cabinet Heaters.
  - 9. Radiant Ceiling Panels.
  - 10. Exhaust fans.
  - 11. Energy Recovery Ventilators.
  - 12. Air Handling Units.
  - 13. Packaged Rooftop Heating and Cooling Units.
  - 14. Packaged Terminal Air Conditioners.
  - 15. Variable Refrigerant Flow Systems.
  - 16. Ductless Split Air Conditioners.
- D. Related Requirements:
  - 1. Section 019113 "General Commissioning Requirements" describes the overall commissioning process and responsibilities for which this contract is responsible.

- E. Abbreviations: The following are common abbreviations used in the Specifications. For additional definitions refer to Section 019113.
  - 1. A/E: Architects and Engineers
  - 2. Cx: Commissioning
  - 3. CxA: Commissioning Authority
  - 4. Cx Plan: Commissioning Plan Document
  - 5. CC: Controls Contractor
  - 6. CM: Construction Manager
  - 7. EC: Electrical Contractor
  - 8. FT: Functional Performance Test
  - 9. MC: Mechanical Contractor
  - 10. PFI: Pre-Functional Inspection
  - 11. TAB: Test and Balance Contractor

## 1.2 INFORMATIONAL SUBMITTALS

- A. Prefunctional Checklists
  - 1. Submit according to the procedures defined in the Commissioning Plan and as agreed at the commissioning scoping meeting.
- B. Startup and Manufacturer Test Reports
  - 1. Obtain copies of all startup reports as well as any test reports prepared by factory authorized service representatives as required by the specification section for each commissioned system. Promptly provide copies of reports to the CxA, as requested.
- C. Requests for Clarification
  - 1. The CxA may request supplemental written clarification for items which are not clearly indicated in equipment submittal documentation. Where such requests are made, the MC shall provide written responses to the CxA within 5 business days. Examples of such requests may include, but are not limited to, clarification of equipment operating sequences, performance data, startup requirements, selected options or accessories, etc.

## PART 2 PRODUCTS (NOT APPLICABLE)

## PART 3 EXECUTION

### 3.1 MEETINGS

- A. Attend commissioning meetings as described in the General Commissioning Requirements.

- B. Commissioning meetings may be scheduled separately from regular construction progress meetings, at the discretion of the CM and CxA.

### 3.2 COORDINATION AND SCHEDULING

- A. MC shall coordinate schedule for prefunctional checklists and equipment startup with CxA.
- B. CxA shall review and approve prefunctional checklists and equipment startup reports prior to scheduling functional testing.

### 3.3 PREFUNCTIONAL CHECKLISTS

- A. Blank copies of the required checklists will be provided by the CxA for use by the MC.
- B. Completed copies of checklists shall be submitted to the CxA according to the procedures defined in the Commissioning Plan and as agreed at the commissioning scoping meeting.
- C. Where checklists require sign-off by multiple parties (e.g. checking of electrical connections by the EC on equipment provided by the MC) each party shall complete their respective portions of the checklist and shall organize all documentation into a single, comprehensive checklist record. Responsible parties shall be indicated by the CxA on each checklist.
- D. The MC shall submit any requests for direction on completion of checklists in writing to the CM and CxA.

### 3.4 FUNCTIONAL PERFORMANCE TESTING

- A. The objective of functional performance testing is to demonstrate that each commissioned system is installed and operating in accordance with the documented design intent. Functional testing shall commence only after all prefunctional inspections, manufacturer testing and startup activities are complete.
- B. The detailed functional testing requirements for each commissioned system will be established in the Commissioning Plan and the Functional Testing Procedures to be developed by the CxA.
- C. Before test procedures are written, the CxA shall obtain all requested documentation related to the intended functional performance of the commissioned systems. This includes submittal documentation, change orders, requests for information, design clarifications, and updated controls system programming information (points lists, control sequences, etc).

- D. MC shall provide assistance to the CxA by reviewing the procedures and responding to questions and concerns posed by the CxA.
- E. General testing requirements:
  - 1. Certify that HVAC systems, subsystems, and equipment have been installed, calibrated, and started and are operating in accordance with the Contract Documents and approved Shop Drawings and submittals.
  - 2. Certify that HVAC instrumentation and control systems have been completed and calibrated, that they are operating in accordance with the Contract Documents and approved Shop Drawings and submittals, and that pretest set points have been recorded.
  - 3. Set systems, subsystems, and equipment into operating mode to be tested in accordance with approved test procedures (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
  - 4. Measure capacities and effectiveness of systems, assemblies, subsystems, equipment, and components, including operational and control functions to verify compliance with acceptance criteria.
  - 5. Test systems, assemblies, subsystems, equipment, and components operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and response in accordance with commissioning and acceptance test criteria.

### 3.5 SEASONAL TESTING

- A. Where seasonal tests are specified, scheduled, or otherwise required by the CxA, the MC shall provide qualified personnel to assist with execution of tests. Where required, the MC shall also secure the services of factory-authorized personnel who are fully capable of executing the required tests.

### 3.6 MANUFACTURER'S FIELD SERVICE

- A. Where required in these specifications, the MC shall retain the services of a factory-authorized representative, vendor's representative, or third-party testing service to carry out equipment startup and testing services (hereby referred to as "Manufacturer's Field Service").
- B. The MC shall ensure that the contract for Manufacturer's Field Service contains sufficient time, in addition to normal startup activities, for the representative to assist the commissioning team in completing functional performance tests. The scope and schedule of testing will be directed by the CxA. This requirement applies to service contracts for each of the commissioned system identified in these specifications.

- C. It shall be the responsibility of the Contractor to specifically request and secure all Manufacturer's Field Services necessary for the startup and commissioning activities specified in the contract documents. Where the standard Manufacturer's Field Service proposed by a vendor or third party service representative may otherwise be insufficient, the necessary services shall be secured during the equipment procurement process.
- D. Following correction of deficiencies, the MC shall arrange for Manufacturer's Field Service required to re-test previously deficient systems, as directed by the CxA.

### 3.7 DEFICIENCIES, NON-CONFORMANCE AND APPROVAL OF TESTS

- A. MC shall be responsible for responding to deficiencies or items of non-conformance related to the system.
- B. Where deficiencies are identified during the commissioning process, the MC shall issue a written response.
- C. Deficiencies shall be corrected in a timely manner. Once corrections are made, notify the CxA that the system(s) are ready for re-inspection and/or re-testing.
- D. Items which are not corrected, require multiple inspections by the CxA to resolve, or which result in scheduling delays may result in back charges to the responsible party. Refer to the section entitled "Documentation, Non-Conformance and Approval of Tests" in section 019113 for additional information on deficiency resolution.
- E. Upon successful completion of testing for each system, the CxA will document the results of testing in the functional testing record. A copy of the test record shall be included in the commissioning documentation to be provided to the Owner upon completion of commissioning.

### 3.8 OWNER TRAINING

- A. Training shall be provided by the MC in coordination with the Owner, CM and CxA. Adequacy of training shall be verified by the CxA, though the CxA may opt not attend all portions of training. For detailed training requirements, refer to section 019113 "General Commissioning Requirements" as well as the requirements contained within the individual equipment specifications.

### 3.9 PERSONNEL

- A. Provide qualified technicians, instrumentation, tools and equipment during the startup, functional testing, and seasonal testing of the commissioned systems. Ensure the availability of at least one individual on site during commissioning tests.

END OF SECTION

## SECTION 230900 - BUILDING AUTOMATION SYSTEM

### PART 1 GENERAL

#### 1.1 OVERVIEW

- A. Expand existing building automation system (BAS) at each building to provide the control sequences specified on drawings. The system shall provide control and monitoring of the equipment indicated.
- B. Provide controllers and communications infrastructure to match existing BAS in each building. Provide seamless integration with existing control network and user interfaces. Network gateways and protocol interface equipment are not acceptable.
- C. Provide instrumentation, valves, dampers, actuators and wiring as required to provide specified operating sequences.
- D. Modify existing graphical user interfaces and/or provide new graphical user interfaces to include all equipment/systems included in this project.
- E. Replace the existing BAS server hardware and upgrade the software to the latest version of web-enabled graphical user interface with a seamless integration of the new and existing control points.

#### 1.2 SCOPE OF WORK

- A. The Contractor shall furnish and install all necessary software and hardware, wiring, and computing equipment in compliance with this specification. Any variances from this specification or related documentation shall be submitted in writing at the time of bid.
- B. System Requirements
  - 1. Standard Material/Products. All material and equipment used shall be standard components, regularly manufactured and available, and not custom designed especially for this project
  - 2. Modular Design. The system architecture shall be fully modular permitting expansion of application software, system peripherals, and field hardware.
  - 3. Performance. The system, upon completion of the installation and prior to acceptance of the project, shall perform all operating functions as detailed in this specification.
  - 4. Equipment: The Contractor shall provide the following system hardware:
    - a. All sensing devices, relays, switches, indicating devices, and transducers required to perform the functions as listed in I/O Summary Tables.
    - b. All monitoring and control wiring.

### 1.3 CODES AND STANDARDS

- A. Work, materials, and equipment shall comply with the most restrictive of local, state, and federal authorities' codes and ordinances or these plans and specifications. As a minimum, the installation shall comply with current editions in effect 30 days prior to receipt of bids of the following codes:
  - 1. National Electric Code (NEC)
  - 2. New York State Building Codes
  - 3. ANSI/ASHRAE 135-2004: Data Communication Protocol for Building Automation and Control Systems (BACnet)
- B. Conflict of Codes. Where two or more codes conflict, the most restrictive shall apply. Nothing in this specification or related documentation shall be construed to permit work not conforming to applicable codes.

### 1.4 SYSTEM PERFORMANCE

- A. Performance Standards. System shall conform to the following minimum standards.
  - 1. Performance. Programmable controllers shall be able to completely execute DDC PID control loops at a frequency adjustable down to once per sec. Select execution times consistent with the mechanical process under control.
  - 2. Reporting Accuracy. System shall report values with minimum end-to-end accuracy listed in Table 1.
  - 3. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed in Table 2.

| TABLE 1 - REPORTING ACCURACY |                                 |
|------------------------------|---------------------------------|
| MEASURED VARIABLE            | REPORTED ACCURACY               |
| SPACE TEMPERATURE            | ±0.5°C (±1°F)                   |
| DUCTED AIR                   | ±0.5°C (±1°F)                   |
| OUTSIDE AIR                  | ±1.0°C (±2°F)                   |
| DEW POINT                    | ±1.5°C (±3°F)                   |
| WATER TEMPERATURE            | ±0.5°C (±1°F)                   |
| DELTA-T                      | ±0.15°C (±0.25°F)               |
| RELATIVE HUMIDITY            | ±5% RH                          |
| WATER FLOW                   | ±2% OF FULL SCALE               |
| AIRFLOW (TERMINAL)           | ±10% OF FULL SCALE (SEE NOTE 1) |
| AIRFLOW (MEASURING STATIONS) | ±5% OF FULL SCALE               |
| AIRFLOW (PRESSURIZED SPACES) | ±3% OF FULL SCALE               |
| AIR PRESSURE (DUCTS)         | ±25 PA (±0.1 IN. W.G.)          |
| AIR PRESSURE (SPACE)         | ±3 PA (±0.01 IN. W.G.)          |



|                                    |                                |
|------------------------------------|--------------------------------|
| WATER PRESSURE                     | ±2% OF FULL SCALE (SEE NOTE 2) |
| ELECTRICAL (A, V, W, POWER FACTOR) | ±1% OF READING (SEE NOTE 3)    |
| CARBON MONOXIDE (CO)               | ±5% OF READING                 |
| CARBON DIOXIDE (CO2)               | ±50 PPM                        |

## 1.5 NOTES

- A. Note 1: Accuracy applies to 10% - 100% of scale
- B. Note 2: For both absolute and differential pressure
- C. Note 3: Not including utility-supplied meters

TABLE 2 - CONTROL STABILITY AND ACCURACY

| CONTROLLED VARIABLE | CONTROL ACCURACY                                 | RANGE OF MEDIUM   |
|---------------------|--|---|
| AIR PRESSURE        | ±50 PA (±0.2 IN. W.G.)<br>±3 PA (±0.01 IN. W.G.) | 0-1.5 KPA (0-6 IN. W.G.)<br>-25 TO 25 PA (-0.1 TO 0.1 IN. W.G.) |
| AIRFLOW             | ±10% OF FULL SCALE                               |   |
| SPACE TEMPERATURE   | ±1.0°C (±2.0°F)                                  |   |
| DUCT TEMPERATURE    | ±1.5°C (±3°F)                                    |   |
| HUMIDITY            | ±5% RH   |   |
| FLUID PRESSURE      | ±10 KPA (±1.5 PSI)<br>±250 PA (±1.0 IN. W.G.)    | MPA (1-150 PSI)<br>0-12.5 KPA (0-50 IN. W.G.)<br>DIFFERENTIAL   |

## 1.6 SUBMITTALS, DOCUMENTATION, ACCEPTANCE AND TRAINING

- A. Submittals:
  - 1. Shop Drawings. Include a complete list of equipment, materials, manufacturer's technical literature, cut-sheets, and installation instructions. Drawings shall contain proposed layout, complete wiring, routing, schematic diagrams, tag number of devices, software descriptions, calculations, installation details, and any other details required to demonstrate that the system will function properly.
  - 2. Graphical Programming Documentation: The Contractor shall submit for approval, all proposed graphic displays in full color hard copy and an electronic copy in HTML format viewable on any web browser for all Graphical Displays, identifying the specific subsystem being controlled. Provide no later than 45 calendar days after contract award.

3. As Built Drawings. All drawings shall be reviewed after the final system checkout and updated or corrected to provide 'as-built' drawings to show exact installation. All shop drawings will be acknowledged in writing by Architect/Engineer before installation is started and again after the final checkout of the system. The system will not be considered complete until the 'as-built' drawings have received their final approval. The Contractor shall as-built drawings in electronic format as PDF documents.
- B. Documentation:
1. Operating and Maintenance (O&M) manuals for the system shall be made available electronically (PDF) and include the following categories: Project Engineering Handbook, Software Documentation.
  2. Project Engineering Manual shall contain as a minimum:
    - a. System architecture overview
    - b. Hardware cut-sheets and product descriptions.
    - c. The Contractor shall deliver six (6) sets of 'as-built' drawings. All drawings shall be reviewed after the final system checkout and updated to provide 'as-built' drawings. The system will not be considered complete until the 'as-built' drawings have received their final approval.
    - d. Installation, mounting and connection details for all field hardware and accessories
    - e. Commissioning, setup and backup procedures for all control modules/accessories, BAS server software, and database.
    - f. Listing of basic terminology, alarms/messages, error messages and frequently used commands or shortcuts.
    - g. Operator training 'video' submitted on CD or DVD format.
  3. Acceptance Test
    - a. Acceptance Testing. Upon completion of the installation, the Contractor shall start up the system and perform all necessary calibration, testing, and debugging operations. The Contractor in the presence of the Owner's representative shall perform an acceptance test.
    - b. Notice of Completion. When the system performance is deemed satisfactory, the system parts will be accepted for beneficial use and placed under warranty. At this time, Architect/Engineer shall issue a "notice of substantial completion" and the warranty period shall start.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Use new products the manufacturer is currently manufacturing and selling for use in new installations. Do not use this installation as a product test site unless explicitly approved in writing by Owner. Spare parts shall be available for at least five years after completion of this contract.

## 2.2 COMMUNICATION

- A. Install new wiring and network devices as required to provide a complete and workable control network.

## 2.3 FIELD HARDWARE/INSTRUMENTATION

### A. Temperature Sensing Devices

1. Type & Accuracy. Temperature sensors shall be of the type and accuracy indicated for the application. Sensors shall have an accuracy rating within 1% of the intended use temperature range.
2. Outside Air Temperature Sensors. Outside air temperature sensors' accuracy shall be within  $\pm 1^{\circ}\text{F}$  in the range of  $-52^{\circ}\text{F}$  to  $152^{\circ}\text{F}$ .
3. Room Temperature Sensors. Room temperature sensors shall have an accuracy of  $\pm 0.36^{\circ}\text{F}$  in the range of  $32^{\circ}\text{F}$  to  $96^{\circ}\text{F}$ .
4. Chilled Water and Condenser Water Sensors. Chilled water and condenser water sensors shall have an accuracy of  $\pm 0.25^{\circ}\text{F}$  in their range of application.
5. Hot Water Temperature Sensors. Hot water temperature sensors shall have an accuracy of  $\pm 0.75^{\circ}\text{F}$  over the range of their application.

### B. Pressure Instruments

1. Differential Pressure and Pressure Sensors: Sensors shall have a 4-20 MA output proportional signal with provisions for field checking. Sensors shall withstand up to 150% of rated pressure, without damaging the device. Accuracy shall be within  $\pm 2\%$  of full scale. Sensors shall be manufactured by Leeds & Northrup, Setra, Robertshaw, Dwyer Instruments, Rosemont, or be approved equal.
2. Pressure Switches: Pressure switches shall have a repetitive accuracy of  $\pm 2\%$  of range and withstand up to 150% of rated pressure. Sensors shall be diaphragm or bourdon tube design. Switch operation shall be adjustable over the operating pressure range. The switch shall have an application rated Form C, snap-acting, self-wiping contact of platinum alloy, silver alloy, or gold plating.

### C. Flow Switches:

1. Flow switches shall have a repetitive accuracy of  $\pm 1\%$  of their operating range. Switch actuation shall be adjustable over the operating flow range. Switches shall have snap-acting Form C contacts rated for the specific electrical application.

### D. Humidity Sensors:

1. Sensors shall have an accuracy of +2.5% over a range of 20% to 95% RH.
- E. Current Sensing Relays
  1. Relays shall monitor status of motor loads. Switch shall have self-wiping, snap-acting Form C contacts rated for the application. The setpoint of the contact operation shall be field adjustable.
- F. Output Relays
  1. Control relay contacts shall be rated for 150% of the loading application, with self-wiping, snap-acting Form C contacts, enclosed in dustproof enclosure. Relays shall have silver cadmium contacts with a minimum life span rating of one million operations. Relays shall be equipped with coil transient suppression devices.
- G. Solid State Relays
  1. Input/output isolation shall be greater than 10 billion ohms with a breakdown voltage of 15 V root mean square, or greater, at 60 Hz. The contact operating life shall be 10 million operations or greater. The ambient temperature range of SSRs shall be 20°F-140°F. Input impedance shall be greater than 500 ohms. Relays shall be rated for the application. Operating and release time shall be 10 milliseconds or less. Transient suppression shall be provided as an integral part of the relays.
- H. Valve and Damper Actuators
  1. Electronic Direct-Coupled: Electronic direct-coupled actuation shall be provided.
  2. Actuator Mounting: The actuator shall be direct-coupled over the shaft, enabling it to be mounted directly to the damper shaft without the need for connecting linkage. The fastening clamp assemble shall be of a 'V' bolt design with associated 'V' shaped toothed cradle attaching to the shaft for maximum strength and eliminating slippage. Spring return actuators shall have a 'V' clamp assembly of sufficient size to be directly mounted to an integral jackshaft of up to 1.05 inches when the damper is constructed in this manner. Single bolt or screw type fasteners are not acceptable
  3. Electronic Overload Sensing: The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the entire rotation of the actuator. Mechanical end switches or magnetic clutch to deactivate the actuator at the end of rotation are not acceptable.
  4. Power Failure/Safety Applications: For power failure/safety applications, an internal mechanical spring return mechanism shall be built into the actuator housing. Non-mechanical forms of fail-safe operation are not acceptable.
  5. Spring Return Actuators: All spring return actuators shall be capable of both clockwise or counterclockwise spring return operation by simply changing the mounting orientation.

6. Proportional Actuators: Proportional actuators shall accept a 0 to 10VDC or 0 to 20mA control input and provide a 2 to 10VDC or 4 to 20mA operating range. An actuator capable of accepting a pulse width modulating control signal and providing full proportional operation of the damper is acceptable. All actuators shall provide a 2 to 10VDC position feedback signal.
  7. 24 Volts (AC/DC) actuators: All 24VAC/DC actuators shall operate on Class 2 wiring and shall not require more than 10VA for AC or more than 8 watts for DC applications. Actuators operating on 120VAC power shall not require more than 10VA. Actuators operating on 230VAC shall not require more than 11VA.
  8. Non-Spring Return Actuators: All non-spring return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring return actuators with more than 60 in-lb torque shall have a manual crank for this purpose.
  9. Modulating Actuators: All modulating actuators shall have an external, built-in switch to allow reversing direction of rotation.
  10. Conduit Fitting & Pre-Wiring: Actuators shall be provided with a conduit fitting and a minimum 3ft electrical cable, and shall be pre-wired to eliminate the necessity of opening the actuator housing to make electrical connections.
  11. U.L. Listing: Actuators shall be Underwriters Laboratories Standard 873 listed and Canadian Standards Association Class 4813 02 certified as meeting correct safety requirements and recognized industry standards.
  12. Warranty: Actuators shall be designed for a minimum of 60,000 full stroke cycles at the actuator's rated torque and shall have a 2-year manufacturer's warranty, starting from the date of installation. Manufacturer shall be ISO9001 certified.
- I. Control Valves: Provide factory fabricated U.S. forged and assembled electric control valves of type, body material, and pressure class indicated. Where type or body material is not indicated, provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with scheduled or specified maximum pressure drop across control valve. Except as otherwise indicated, provide valves which mate and match material of connecting piping. Equip control valves with control valve motor actuators, with proper shutoff rating for each individual application.
1. Water Service Valves: Equal percentage characteristics with rangeability of 50 to 1, Class 150 at 250°F and maximum full flow pressure drop 5 psig. Globe type with replaceable plugs and seats of stainless steel or brass. Select operators to close valves against pump shutoff head.
  2. Double Seated Valves: Balanced plug type, with caged type trim providing seating and guiding surfaces on "top and bottom" guided plugs.
  3. Valve Trim and Stems: Polished stainless steel.
  4. Packing: Spring-loaded teflon, self-adjusting.

5. Terminal Unit Control Valves: Provide control ball valves for control of terminal units including, but not necessarily limited to, convectors, thinned tube radiation, and fan coil - units that are of integral motor type. Provide 2-position or modulating type valves, electrically actuated by line voltage or by 24VAC.
- J. Dampers: Provide automatic control low leakage, opposed blade dampers, with damper frames not less than formed 13-gauged galvanized steel. Provide mounting holes for enclosed duct mounting. Provide damper blades not less than formed 16-gauged galvanized steel, with maximum blade width of 8-inch. Equip dampers with motors of proper rating of each application.
  1. Secure blades to ½ inch diameter zinc-plated axles using zinc-plated hardware. Seal off against spring stainless steel blade bearings. Provide blade bearings Nylon and provide thrust bearings at each end of every blade. Construct blade linkage hardware of zinc-plated steel and brass. Submit leakage and flow characteristics plus size schedule for controlled dampers.
  2. Operating Temperature Range: From -20° to 200°F (-29° to 93°C).
  3. For low leakage application or opposed blade design (as selected by manufacturers sizing techniques) with inflatable steel blade edging or replaceable rubber seals, rated for leakage less than 10 cfm per square foot of damper area, AR differential pressure of 4-inch w.g. when damper is being held by torque 50 inch-pounds.

## PART 3 EXECUTION

### 3.1 COORDINATION

- A. Provide power from existing electrical distribution system as necessary for control system. Comply with the National Electrical Code.

### 3.2 INSTALLATION

- A. Connect and configure equipment and software to achieve sequence of operation specified.
- B. Verify location of exposed control sensors with architect prior to installation. Install devices 60 inches above the floor.
- C. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

### 3.3 ELECTRICAL WIRING SCOPE

- A. This contractor shall be responsible for power that is not shown on the electrical drawings, to controls furnished by this contractor. If power circuits are shown on the electrical drawings, this contractor shall continue the power run to the control device. If power circuits are not shown, this contractor shall coordinate with the electrical contractor to provide breakers at distribution panels for power to controls. This contractor is then responsible for power from the distribution panel.
  - 1. Coordinate panel locations. If enclosures for panels are shown on the electrical drawings, furnish the enclosures according to the electrician's installation schedule.
- B. This contractor shall not be responsible for power to control panels and control devices that are furnished by others, unless it is part of the control interlock wiring.
- C. Refer to Coordination section for what devices this contractor is responsible to mount and which are turned over to others to mount.
- D. This contractor shall be responsible for wiring of any control device that is furnished as part of this section of specification.
- E. Wiring for controls furnished by others:
  - 1. Provide control wiring for HVAC controls furnished by others. Wiring may include, but not limited to, the following items:
    - a. Thermostats
    - b. Condensers
    - c. Chiller control devices shipped loose
    - d. Leak detectors
    - e. Humidifier controls
    - f. Refrigerant leak monitoring systems
    - g. Exhaust or Purge fans
    - h. Manual switches for HVAC equipment (not shown on electrical drawings)
    - i. Emergency ventilation switches (not shown on electrical drawings)
    - j. Emergency shutdown switches (not shown on electrical drawings)
  - 2. Provide control wiring for the following non-HVAC controls furnished by others if they are called for in this project:
    - a. Electrical vault fans
    - b. Emergency generator dampers
    - c. Water treatment
    - d. Interlock to fire suppression system
    - e. Leak detection system
    - f. Fuel oil monitoring system
    - g. Fuel oil fill system
- F. Interlock wiring shall be run in separate conduits from BAS associated wiring.

- G. Provide network wiring for equipment that is called to be integrated to the BAS.

### 3.4 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. Install raceways, boxes, and cabinets according to Section 260533 "Raceways and Boxes for Electrical Systems."
- B. Install building wire and cable according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Install signal and communication cable according to Section 271500 "Communications Horizontal Cabling."
  - 1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
  - 2. Install exposed cable in raceway.
  - 3. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
  - 4. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
  - 5. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
  - 6. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- D. Connect manual reset limit controls independent of manual control switch positions.
- E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

### 3.5 COMMUNICATION WIRING

- A. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.
- B. Do not install communication wiring in raceway and enclosures containing Class 1 wiring.
- C. Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.
- D. Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.
- E. Cable bundling:
  - 1. RS485 cabling run open air in accessible areas can be bundled with other class 2 low voltage cabling.



2. RS485 cabling run between terminal units in conduits above ceilings or under floors or in inaccessible areas can be bundled with other class 2 low voltage cabling.
  3. RS485 cabling run between floors shall be in a communication only conduit.
  4. RS485 conduit run long distances between utility rooms or between buildings shall be in a communication only conduit.
  5. Ethernet cabling shall be in a communication only conduit.
  6. Ethernet and RS485 can be run together.
  7. Fiber optics can be run with Ethernet and RS485 cabling as long as the conduit is bent to fiber optic standards and junction boxes are sized for fiber optic use.
- F. FLN or BACnet BACnet MS/TP Cabling
1. RS485 cabling shall be used for BACnet MS/TP networks.
  2. RS485 shall use low capacitance, 20-24 gauge, twisted shielded pair.
  3. The shields shall be tied together at each device.
  4. The shield shall be grounded at one end only and capped at the other end.
  5. Provide end of line (EOL) termination devices at each end of the RS485 network or subnetwork run, to match the impedance of the cable, 100 to 120ohm.
- G. Ethernet Cabling
1. Ethernet shall not be run with any Class 1 or low voltage Class 2 wiring.
  2. CAT6, unshielded twisted pair (UTP) cable shall be used for BAS Ethernet.
  3. Solid wire shall be used for long runs, between mechanical rooms and between floors. Stranded cable can be used for patch cables and between panels in the same mechanical room up to 50 feet away.
  4. When the BAS Ethernet connects to an Owner's network switch, document the port number on the BAS As-builts.
- H. When a cable enters or exits a building, a lightning arrestor must be installed between the lines and ground. The lighting arrestor shall be installed according to the manufacturer's instructions.
- I. All runs of communication wiring shall be unspliced length when that length is commercially available.
- J. All communication wiring shall be labeled to indicate origination and destination data.
- K. Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."
- 3.6 FIELD QUALITY CONTROL
- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

- B. Perform the following field tests and inspections and prepare test reports:
  - 1. 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. Test each point through its full operating range to verify that safety and operating control set points are as required.
  - 4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
  - 5. Test each system for compliance with sequence of operation.
  - 6. Test software and hardware interlocks.
- C. DDC Verification:
  - 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
  - 2. Check instruments for proper location and accessibility.
  - 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
  - 4. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
  - 5. Check control valves. Verify that they are in correct direction.
  - 6. Check DDC system as follows:
    - a. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    - b. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

### 3.7 SYSTEM COMMISSIONING, DEMONSTRATION AND TURNOVER

- A. The BAS Contractor shall prepare and submit for approval a complete acceptance test procedure including submittal data relevant to point index, functions, sequence, interlocks, and associated parameters, and other pertinent information for the operating system. Prior to acceptance of the BAS by the Owner and Engineer, the BAS contractor shall completely test the BAS using the approved test procedure.
- B. After the BAS contractor has completed the tests and certified the BAS is 100% complete, the Engineer shall be requested, in writing, to approve the satisfactory operation of the system, sub-systems and accessories. The BAS contractor shall submit Maintenance and Operating manuals at this time for approval. An acceptance test in the presence of the Engineer and Owner's representative shall be performed. The Owner will then shake down the system for a fixed period of time (30 days).

- C. The BAS contractor shall fix punch list items within 30 days of acceptance.
- D. When the system performance is deemed satisfactory in whole or in part by these observers, the system parts will be accepted for beneficial use and placed under warranty.

### 3.8 PROJECT RECORD DOCUMENTS

- A. Project Record Documents: Submit three (3) copies of record (as-built) documents upon completion of installation. Submittal shall consist of:
  - 1. Project Record Drawings. As-built versions of the submittal shop drawings provided as AutoCAD compatible files in electronic format and as 11 x 17 inch prints.
  - 2. Testing and Commissioning Reports and Checklists. Completed versions of reports, checklists, and trend logs used to meet requirements in the Control System Demonstration and Acceptance section of this specification.
  - 3. Operation and Maintenance (O & M) Manual.
    - a. As-built versions of the submittal product data.
    - b. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
    - c. Operator's Manual with procedures for operating control systems, logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
    - d. Programming manual or set of manuals with description of programming language and of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
    - e. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
    - f. Documentation of all programs created using custom programming language, including setpoints, tuning parameters, and object database.
    - g. Graphic files, programs, and database on electronic media.
    - h. List of recommended spare parts with part numbers and suppliers.
    - i. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.
    - j. Complete original original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
    - k. Licenses, guarantees, and warranty documents for equipment and systems.

- B. Operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system. As a minimum include the following:
  - 1. Sequence of operation for automatic and manual operating modes for all building systems. The sequences shall cross-reference the system point names.
  - 2. Description of manual override operation of all control points in system.
  - 3. BMS system manufacturers complete operating manuals.
- C. Provide maintenance manual to serve as training and reference manual for all aspects of day-to-day maintenance and major system repairs. As a minimum include the following:
  - 1. Complete as-built installation drawings for each building system.
  - 2. Overall system electrical power supply schematic indicating source of electrical power for each system component. Indicate all battery backup provisions.
  - 3. Photographs and/or drawings showing installation details and locations of equipment.
  - 4. Routine preventive maintenance procedures, corrective diagnostics troubleshooting procedures, and calibration procedures.
  - 5. Parts list with manufacturer's catalog numbers and ordering information.
  - 6. Lists of ordinary and special tools, operating materials supplies and test equipment recommended for operation and servicing.
  - 7. Manufacturer's operation, set-up, maintenance and catalog literature for each piece of equipment.
  - 8. Maintenance and repair instructions.
  - 9. Recommended spare parts.
- D. Provide Programming Manual to serve as training and reference manual for all aspects of system programming. As a minimum include the following:
  - 1. Complete programming manuals, and reference guides.
  - 2. Details of any custom software packages and compilers supplied with system.
  - 3. Information and access required for independent programming of system.

### 3.9 TRAINING

- A. During System commissioning and at such time as acceptable performance of the Building Automation System hardware and software has been established, the BAS contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent building automation contractor representative familiar with the Building Automation System's software, hardware and accessories.

- B. At a time mutually agreed upon, during System commissioning as stated above, the BAS contractor shall give 16-hours of onsite training on the operation of all BAS equipment. Describe its intended use with respect to the programmed functions specified. Operator orientation of the automation system shall include, but not be limited to:
  - 1. Explanation of drawings and operator's maintenance manuals.
  - 2. Walk-through of the job to locate all control components.
  - 3. Operator workstation and peripherals.
  - 4. DDC Controller and ASC operation/sequence.
  - 5. Operator control functions including scheduling, alarming, and trending.
  - 6. Explanation of adjustment, calibration and replacement procedures.
- C. Additional 8-hours of training shall be given after the 30 day shakedown period.
- D. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If the Owner requires such training, it will be contracted at a later date. Provide description of available local and factory customer training. Provide costs associated with performing training at an off-site classroom facility and detail what is included in the manufacturer's standard pricing such as transportation, meals, etc.

END OF SECTION 230900

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## SECTION 230993 - SEQUENCE OF OPERATIONS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes building automation monitoring and operating sequences for building systems and equipment as described herein.
- B. This Section includes operating sequences for various pieces of new equipment in multiple buildings. All new equipment shall be connected to existing Building Automation System in each respective building and configured as described below. Contractor is responsible to field verify the existing control system at each building and provide all hardware, control wiring, electrical wiring, programming and graphics to provide a complete installation.

#### 1.2 DEFINITIONS

- A. ADJ - Operator Adjustable
- B. AI - Analog input.
- C. AO - Analog Output.
- D. DDC - Direct digital control.
- E. DI - Digital input.
- F. DO - Digital output.
- G. EAT - Entering air temperature.
- H. EWT - Entering water (fluid) temperature.
- I. LAT - Leaving air temperature.
- J. LWT - Leaving water (fluid) temperature.
- K. OA - Outdoor air.
- L. OAF - Outdoor Airflow (cfm)
- M. OAT - Outdoor air temperature
- N. VFD - Variable frequency drive.
- O. WP - Waterproof/weather resistant.

### 1.3 ACTION SUBMITTALS

- A. Product Data:
  - 1. An instrumentation list for each controlled system. Label each element of the controlled system in table format. Show, in the table element name, type of device, manufacturer, model number, and control device product data sheet number.
  - 2. A complete description of the operation of the control system, including sequences of operation. Include and reference a schematic diagram of the controlled system.
- B. Shop Drawings:
  - 1. Riser diagrams showing control network layout, communication protocol, and wire types.
  - 2. Schematic diagram of each controlled system. Include all control points labeled with point names shown or listed. Show the location of control elements in the system.
  - 3. Wiring diagram for each controlled system. Show all control elements labels. Where a control element is the same as that shown on the control system schematic, label with the same name. Label all terminals.

## PART 2 PRODUCTS

## PART 3 EXECUTION

### 3.1 GENERAL:

- A. Setpoints and schedules described in the operation of building systems shall be operator adjustable unless otherwise indicated.
- B. Unless otherwise noted the space temperature setpoints for each system shall be as follows:

| OPERATING MODE     | SPACE TEMPERATURE SETPOINT |
|--------------------|----------------------------|
| OCCUPIED HEATING   | 70°F                       |
| OCCUPIED COOLING   | 75°F                       |
| UNOCCUPIED HEATING | 60°F                       |
| UNOCCUPIED COOLING | 85°F                       |

- C. Provide digital input from fire alarm system to indicate activation of system. Coordinate interface with the EC.

### 3.2 UNIT VENTILATORS AND EXHAUST FANS



- A. Main System Components
  - 1. Unit ventilator OA/RA damper, modulating type, normally closed.
  - 2. Unit ventilator face and bypass damper, modulating type, normally closed.
  - 3. Unit ventilator supply fan, variable speed, normally off.
  - 4. Hot water coil valve, modulating type, normally open.
  - 5. Chilled water coil valve, modulating type, normally open.
  - 6. Exhaust air isolation damper, 2-position type, normally closed.
  - 7. Exhaust fan, variable speed, normally off.
- B. Hardwired Safeties
  - 1. The area smoke detectors shall shutdown the units and associated exhaust fans on a smoke condition through FAS. The unit shutdown wiring from FAS output module to unit shutdown circuit shall be provided and installed by fire alarm contractor. FAS shall notify BAS to restore normal controls upon deactivation of fire alarm condition.
- C. Provide field installed and wired microprocessor-based controls for unit ventilators, interfaced with the BAS. Provide all devices indicated to complete this sequence of operation.
- D. Provide BACnet control panel mounted on steel plate inside unit ventilator cabinet.
- E. Units shall operate in occupied, unoccupied or morning warm-up mode as scheduled.
- F. Morning Warm-up Mode: The unit fan shall start, the mixed air dampers shall be set to 100% return air position, and heating coil output shall be set to 100%. Room exhaust fan shall be off during warm-up mode. When space temperature reaches occupied setpoint, the system shall switch to occupied mode operation.
  - 1. Provide optimal start algorithm for morning warm-up mode to minimize time of this operation while achieving comfort conditions by the start of the scheduled occupied period.
- G. Occupied Mode: Supply fan and exhaust fan shall run continuously.
  - 1. Mixed Air Damper Control:
    - a. When space temperature is at or below occupied space heating temperature setpoint, OA/RA dampers shall open to minimum OA position (default position determined by TAB agency to provide scheduled design minimum OA flow).
    - b. During occupied mode, exhaust fan shall operate continuously. Exhaust fan shall operate at a minimum speed to match minimum OA position. Exhaust fan speed shall track OA position with any modulation of mixed air dampers.
  - 2. Heating Coil Control:

- a. When OA temperature drops below 40F, the control valve shall open 100% and the face and bypass damper shall modulate to maintain space temperature setpoint.
  - b. When OA temperature rises above 40F, the face and bypass damper shall open to full coil face flow and the control valve shall modulate to maintain space temperature.
  - c. Provide remote wall mounted thermostat with override capability and limited setpoint adjustment +/- 3°F.
- H. Unoccupied Mode: With mixed air dampers set to 100% return air position and exhaust fan off, unit fan and heating coil valve shall cycle as required to maintain unoccupied space temperature setpoint (default = 65°F (adj.) in heating mode.
- I. Economizer Mode:
  1. If return air enthalpy is greater than the outside air enthalpy for more than a period of 15 minutes (adj.), and the outside air temperature is less than 70°F (adj.), and space is calling for cooling, the free cooling economizer mode shall be enabled. Mechanical cooling shall be disabled. Outside air dampers shall modulate open, return air dampers shall modulate close. Exhaust fan should operate at increased fan speed during economization mode to match OA airflow.
  2. If outside air enthalpy is greater than the return air enthalpy for more than a period of 15 minutes (adj.) or if the outside air temperature rises above 70°F (adj.), the free cooling mode shall be disabled, and the unit shall be indexed to the normal occupied temperature control mode with mechanical cooling enabled.
  3. Interlock mechanical cooling capacity control with the air economizer controls such that the outdoor air damper is at the 100 percent open position when mechanical cooling is on and the outdoor air damper does not begin to close to prevent coil freezing due to minimum compressor run time until the leaving air temperature is less than 45°F.
- J. Economizer Fault Detection & Diagnostics
  1. The following temperature sensors shall be permanently installed to monitor system operation:
    - a. Outside air
    - b. Supply Air
    - c. Return Air
  2. Temperature sensors shall have an accuracy of +/- 2°F over the range of 40°F to 80°F.
  3. Refrigerant pressure sensors, where used, shall have an accuracy of +/- 3 percent of full scale.
  4. The unit controller shall be configured to provide system status by indicating the following:
    - a. Free cooling available

- b. Economizer enabled
  - c. Compressor enabled
  - d. Heating enabled
  - e. Mixed air low limit cycle active
  - f. The current value of each sensor
- 5. The unit controller shall be capable of manually initiating each operating mode so that the operation of compressors, economizers, fans and the heating system can be independently tested and verified.
- 6. The unit shall be configured to report faults to a fault management application available for access by day-to-day operating or service personnel or annunciated locally on zone thermostats.
- 7. The fault detection and diagnostics system shall be configured to detect the following faults:
  - a. Air temperature sensor failure/fault
  - b. Not economizing when the unit should be economizing
  - c. Economizing when the unit should not economizing
  - d. Damper not modulating
  - e. Excess outdoor air
- K. Alarms:
  - 1. Monitor and display air filter runtime. Generate filter change alarm when runtime reaches setpoint (default = 1,200 hours).
  - 2. Monitor and display total supply fan runtime.
  - 3. Low DAT (default = 40°F).
  - 4. Low space temperature (default = 50°F).
- L. Safety Controls:
  - 1. On a signal from the respective fire alarm system the unit supply fan shall stop.
  - 2. Provide a freezestat to shut down the unit fan if coil leaving air temperature drops below 38°F. The BAS shall monitor the switch.

M. System Point Summary (typ./each unit):

| Description                          | Type | Remark |
|--------------------------------------|------|--------|
| (1) Zone temperature                 | AI   |        |
| (2) Zone temperature setpoint adjust | AI   |        |
| (3) Supply fan start/stop            | DO   |        |
| (4) Supply fan status                | DI   |        |
| (5) Supply fan speed                 | AO   |        |
| (6) OA/RA damper position            | AO   |        |
| (7) Exhaust fan start/stop           | DO   |        |
| (8) Exhaust fan speed                | AO   |        |
| (9) Exhaust fan status               | DI   |        |

|  |    |  |
|--|----|--|
| (10) EA damper position                | DO |  |
| (11) Mixed air temperature             | AI |  |
| (12) Discharge air temperature         | AI |  |
| (13) Heating coil control valve        | AO |  |
| (14) Heating coil face & bypass damper | AO |  |
| (15) Cooling coil control valve        | AO |  |
| (16) Freezestat                        | DI |  |

### 3.3 PRIMARY/SECONDARY HEATING HOT WATER SYSTEM

#### A. Main System Components

1. Boilers B-1 and B-2, normally off.
2. Primary system pumps VFDs, 0% output. (Pumps P-1 & P-2)
3. Boiler pumps VFDs, 0% output. (Pumps BP-1, BP-2, BP-3, BP-4, BP-5 & BP-6)

#### B. System Description

1. Boilers are in lead/lag configuration and operate sequentially to maintain heating hot water supply temperature at 180°F (Adj.). Heating hot water supply temperature adjustment is via factory installed boiler controls or BACnet integration with BAS.
  - a. Heating hot water supply temperature reset based on OA temperature shall be controlled by the boiler control panel furnished by the boiler manufacturer.
    - 1) 180 °F (Adj.) when OAT is less than 35°F. (Adj.)
    - 2) 150°F (Adj.) when OAT is greater than 62°F (Adj.)
2. Primary loop pumps are in lead/lag configuration.

#### C. System Off

1. When the system is off, all equipment and control valves shall be in their normal position.

#### D. System Start-Up

1. Upon a call for heating hot water supply, the system shall start in following sequences:
  - a. Open the combustion air damper.
  - b. Send an Enable signal to the lead boiler.
  - c. Start lead primary system pump.
  - d. Start the boiler pump associated with the lead boiler. Start the lead boiler upon confirmation of boiler water flow.

#### E. Duty/Standby Boiler Control

1. When primary loop hot water supply temperature drops below the setpoint by 2°F (Adj.) with one boiler in operation for 15 minutes (Adj.), the active boiler shall modulate to ramp up the output through packaged boiler control panel to maintain heating hot water discharge temperature at the setpoint (Adj.).
  2. Upon a continued drop in hot water supply temperature with the lead boiler 100% (Adj.) loaded for 15 minutes (Adj.), the lag boiler shall be energized following system start-up sequences. Both boilers shall be modulated through packaged boiler controls to maintain hot water discharge temperature at the setpoint (Adj.).
  3. When primary loop hot water supply temperature rises above the setpoint by 2°F (Adj.) with both boilers in operation for 15 minutes (Adj.), the active boilers shall modulate to wind down one at a time through packaged boiler control panel to maintain heating hot water discharge temperature at the setpoint (Adj.).
  4. Upon a continued rise in water return temperature for 15 minutes (Adj.) with the lag boiler operating at the minimum flow, the lag boiler shall be de-energized. The lead boiler shall modulate to maintain hot water discharge temperature at the setpoint (Adj.).
  5. Hot water primary loop pumps shall follow pump staging and de-staging sequences to maintain the pressure differential across supply and return headers at the setpoint (Adj.)
  6. To prevent short cycling, boilers shall run for and be off for minimum 20 minutes (Adj.) unless shutdown on safeties or outside air conditions. The boilers shall operate subject to its own internal safeties and controls.
  7. The lead and lag boilers shall rotate every 2 weeks (Adj.).
- F. Duty/Standby Pump Control
1. The lead and lag pumps shall rotate every 2 weeks (Adj.).
  2. On failure of a duty pump, the standby pump shall automatically start, and an alarm is generated at the BAS workstation.
- G. Pump Control
1. Self-sensing pumps shall use integrated sensors and control logic to control pump speed operate at the desired flow rate and/or system pressure. Integrate the pump controllers with the BAS to allow for monitoring of all available points and setpoint adjustment.
- H. Boiler Emergency Stop
1. Provide manually reset momentary contact switch outside each boiler room door. The switch shall be marked as "Emergency Boiler Shutdown".
  2. Wire boiler primary control circuits through switch to de-energize the boilers when the switch is depressed.
  3. Fire Alarm System signals BAS upon the detection of natural gas leakage in the mechanical room. BAS shall shut down the boilers upon receiving the notification sent by FAS.

I. Alarms

1. Provide local audio/visual, and remote alarm at the BAS workstation for the follows
2. Boiler Alarms via packaged burner controls
  - a. Boiler failure: commanded on, but the status is off.
  - b. Boiler running in hand: commanded off, but the status is on.
  - c. Boiler runtime exceeded: status runtime exceeds a user definable limit.
  - d. Low water level alarm.
  - e. Flame failure.
  - f. High primary hot water supply temperature exceeding 200F (adj.)
  - g. Low primary hot water supply temperature below 100F (adj.)
3. Pump Alarms
  - a. Pump VFD fault
  - b. Pump failure: commanded ON, but the status is OFF.
  - c. Pump running in hand: commanded OFF, but the status is ON.
  - d. Circulation pump runtime exceeded: status runtime exceeds a user definable limit
4. Make-up water high limit

J. Boiler Packaged Control Point Summary (each unit):

| Description                  | Type | Remark        |
|------------------------------|------|---------------|
| (1) Supply water temperature | AV   | Virutal Point |
| (2) Return water temperature | AV   | Virutal Point |
| (3) Firing rate              | AV   | Virutal Point |
| (4) Flue gas temperature     | AV   | Virutal Point |
| (5) Flame signal             | AV   | Virutal Point |
| (6) Operating status         | AV   | Virutal Point |
| (7) Ignitions                | AV   | Virutal Point |
| (8) Common Alarms            | AV   | Virutal Point |
| (9) Burner high hours        | AV   | Virutal Point |
| (10) Burner medium hours     | AV   | Virutal Point |
| (11) Burner low hours        | AV   | Virutal Point |

K. Distribution system Point Summary (typ./each unit):

| Description                         | Type | Remark |
|-------------------------------------|------|--------|
| (1) Boiler supply water temperature | AI   |        |
| (2) Boiler return water temperature | AI   |        |
| (3) Boiler flow control valves      | AO   |        |
| (4) Header supply water temperature | AI   |        |
| (5) Header return water temperature | AI   |        |

|                                   |    |     |
|-----------------------------------|----|-----|
| (6) Header differential pressure  | AI |     |
| (7) Header supply water flow rate | AI |     |
| (8) Make-up water flow rate       | AI |     |
| (9) Pump status                   | DI | VFD |
| (10) Pump start/stop              | DO | VFD |
| (11) Pump speed                   | AO | VFD |
| (12) Pump fault                   | DI | VFD |
| (13) Pump differential pressure   | AI | VFD |
| (14) Pump flow rate               | AI | VFD |
| (15) CO sensor                    | AI |     |
| (16) Combustion air damper        | DO |     |
| (17) Natural gas detection sensor | AI |     |

### 3.4 CHILLED WATER SYSTEM

#### A. Main System Components

1. Chiller CH-1
2. Chilled water pumps VFDs, 0% output. (Pumps P-3 & P-4)

#### B. System Description

1. There will be no changes to the operation of the existing chilled water side of the cooling system with the exception of the chilled water pumps. All existing sensors, valves, flow meters, etc. on the chilled water side of the system will remain as is.
2. Chilled water pumps are in lead/lag configuration.
  - a. Heating hot water supply temperature reset based on OA temperature shall be controlled by the boiler control panel furnished by the boiler manufacturer.
    - 1) 180 °F (Adj.) when OAT is less than 35°F. (Adj.)
    - 2) 150°F (Adj.) when OAT is greater than 62°F (Adj.)
3. Primary loop pumps are in lead/lag configuration.

#### C. Chilled Water Duty/Standby Pump Control

1. The lead and lag pumps shall rotate every 2 weeks (Adj.).
2. On failure of a duty pump, the standby pump shall automatically start, and an alarm is generated at the BAS workstation.

#### D. System Off

1. When the system is off, all equipment and control valves shall be in their normal position.

#### E. System Start-Up

1. Upon a call for chilled water supply, the system shall start in following sequences:

- a. Send an Enable signal to the chiller.
- b. Start lead pump.

F. Pump Control

1. Self-sensing pumps shall use integrated sensors and control logic to control pump speed operate at the desired flow rate and/or system pressure. Integrate the pump controllers with the BAS to allow for monitoring of all available points and setpoint adjustment.

G. Alarms

1. Provide local audio/visual, and remote alarm at the BAS workstation for the following
2. Chiller Alarms via factory controller
  - a. Evaporator Flow Loss
  - b. Evaporator Water Freeze Protect
  - c. Evaporator LWT Sensor Fault
  - d. Evaporator EWT Sensor Fault
  - e. Outdoor Air Temperature Sensor Fault
  - f. Evaporator Pump #1 Failure
  - g. Evaporator Pump #2 Failure
  - h. Low Evaporator Pressure
  - i. High Condenser Pressure
  - j. Mechanical Low Pressure Switch
  - k. Mechanical High Pressure Switch
  - l. Motor Protection Fault
  - m. Low OAT Restart Fault
  - n. No Pressure Change After Start
  - o. Evaporator Pressure Sensor Fault
  - p. Condenser Pressure Sensor Fault
  - q. Suction Temperature Sensor Fault
3. Pump Alarms
  - a. Pump VFD fault
  - b. Pump failure: commanded ON, but the status is OFF.
  - c. Pump running in hand: commanded OFF, but the status is ON.
  - d. Circulation pump runtime exceeded: status runtime exceeds a user definable limit
4. Make-up water high limit

H. Point Summary (typ./each unit):

| Description                            | Type | Remark |
|--|------|--------|
| (1) Chiller status                     | AI   |        |
| (2) Leaving water temperature setpoint | AO   |        |
| (3) Chiller leaving water temperature  | AI   |        |



|                                   |    |     |
|-----------------------------------|----|-----|
| (4) Supply water temperature      | AI |     |
| (5) Return water temperature      | AI |     |
| (6) Header differential pressure  | AI |     |
| (7) Header supply water flow rate | AI |     |
| (8) Make-up water flow rate       | AI |     |
| (9) Pump status                   | DI | VFD |
| (10) Pump start/stop              | DO | VFD |
| (11) Pump speed                   | AO | VFD |
| (12) Pump fault                   | DI | VFD |
| (13) Pump differential pressure   | AI | VFD |
| (14) Pump flow rate               | AI | VFD |

### 3.5 VARIABLE REFRIGERANT FLOW SYSTEM

- A. Provide factory installed and wired microprocessor based controls with split systems, interfaced with the BAS. Install any manufacturer supplied devices and provide any field supplied devices to complete this sequence of operation.
- B. Provide BACnet communications interface. Controls are built into the units and shall communicate with the BAS. Display all available points on system graphic user interface.
- C. Units shall operate in occupied or unoccupied as scheduled.
- D. Occupied Mode: Supply fan shall run continuously. Energy recovery ventilator shall run continuously while split systems are in occupied mode.
  - 1. Space Temperature Control:
    - a. Heat pump shall operate in heating or cooling mode via integral control sequences as required to maintain space temperature setpoint.
    - b. Space temperature setpoint shall be user adjustable from BAS.
      - 1) Cooling Setpoint = 75°F (adj.)
      - 2) Heating Setpoint = 70°F (adj.)
    - c. Provide remote wall mounted thermostat with override capability and limited setpoint adjustment +/- 3°F.
- E. Unoccupied Cooling Mode: Unit fan and heat pump operation shall cycle integral control sequences as required to maintain unoccupied space temperature setpoint (default = 80°F (adj.) in cooling mode).
- F. Unoccupied Heating Mode: Unit fan and heat pump operation shall cycle integral control sequences as required to maintain unoccupied space temperature setpoint (default = 65°F (adj.) in heating mode).
- G. Alarms:

1. Monitor and display air filter runtime. Generate filter change alarm when runtime reaches setpoint (default = 1,200 hours).
2. Low DAT (default = 40°F).
3. Low space temperature (default = 50°F).

H. Safety Controls:

1. On a signal from the respective fire alarm system the unit supply fan shall stop.

I. Point Summary (typ./each unit):

| Description                          | Type | Remark |
|--------------------------------------|------|--------|
| (1) Zone temperature                 | AI   |        |
| (2) Zone temperature setpoint adjust | AI   |        |
| (3) Supply fan start/stop            | DO   |        |
| (4) Supply fan status                | DI   |        |
| (5) Supply fan speed                 | AO   |        |
| (6) Discharge air temperature        | AI   |        |
| (7) Unit status - operating mode     | AI   |        |

### 3.6 ENERGY RECOVERY VENTILATOR

- A. General Description: Packaged unit including energy recovery media, supply fan, exhaust fan, filters, and dampers.
- B. Function: Provide continuous supply of tempered outdoor air for general ventilation during occupied hours. Provide exhaust air and energy recovery to temper outdoor air. Unit shall run in conjunction with split systems in main office.
- C. Occupied Mode: Schedule unit to run continuously. During operation, outside and exhaust air dampers shall be powered open, supply and exhaust blowers and energy wheel shall operate.
- D. Unoccupied Mode: Unit shall remain off during scheduled unoccupied periods. Outside and exhaust air dampers shall be closed when unit is off.
- E. Safety Controls:
1. On a signal from the respective fire alarm system the unit supply and exhaust fan shall stop.

F. Point Summary (typ./each unit):

| Description                    | Type | Remark |
|--------------------------------|------|--------|
| (1) ERV unit start/stop        | DO   |        |
| (2) Fan status                 | DI   |        |
| (3) Fan speed                  | AO   |        |
| (4) Unit discharge temperature | AI   |        |

|                        |    |  |
|------------------------|----|--|
| (5) OA damper position | DO |  |
| (6) EA damper position | DO |  |

### 3.7 SPLIT SYSTEM HEAT PUMP

- A. Provide factory installed and wired microprocessor based controls with split systems, interfaced with the BAS. Install any manufacturer supplied devices and provide any field supplied devices to complete this sequence of operation.
- B. Provide BACnet communications interface. Controls are built into the units and shall communicate with the BAS. Display all available points on system graphic user interface.
- C. Units shall operate in occupied or unoccupied as scheduled.
- D. Occupied Mode: Supply fan shall run continuously. Energy recovery ventilator shall run continuously while split systems are in occupied mode.
  - 1. Space Temperature Control:
    - a. Heat pump shall operate in heating or cooling mode via integral control sequences as required to maintain space temperature setpoint.
    - b. Space temperature setpoint shall be user adjustable from BAS.
      - 1) Cooling Setpoint = 75°F (adj.)
      - 2) Heating Setpoint = 70°F (adj.)
    - c. Provide remote wall mounted thermostat with override capability and limited setpoint adjustment +/- 3°F.
- E. Unoccupied Mode: Unit fan and heat pump operation shall cycle integral control sequences as required to maintain unoccupied space temperature setpoint (default = 65°F (adj.) in heating mode and 80°F (adj.) in cooling mode).
- F. Alarms:
  - 1. Monitor and display air filter runtime. Generate filter change alarm when runtime reaches setpoint (default = 1,200 hours).
  - 2. Low DAT (default = 40°F).
  - 3. Low space temperature (default = 50°F).
- G. Safety Controls:
  - 1. On a signal from the respective fire alarm system the unit supply fan shall stop.
- H. Point Summary (typ./each unit):

| Description                          | Type | Remark |
|--------------------------------------|------|--------|
| (1) Zone temperature                 | AI   |        |
| (2) Zone temperature setpoint adjust | AI   |        |
| (3) Supply fan start/stop            | DO   |        |
| (4) Supply fan status                | AI   |        |

|                                  |    |  |
|----------------------------------|----|--|
| (5) Supply fan speed             | AO |  |
| (6) Discharge air temperature    | AI |  |
| (7) Unit status - operating mode | AI |  |

### 3.8 CABINET UNIT HEATERS

- A. Unit heaters shall operate in occupied or unoccupied mode as scheduled. Units shall be off when building heating system is off.
- B. Occupied Mode: Unit control valve and fan shall be cycled to maintain occupied space heating temperature setpoint.
- C. Unoccupied Mode: Unit control valve and fan shall be cycled to maintain unoccupied space heating temperature setpoint.
- D. Point Summary (typ./each unit):

| Description                          | Type | Remark |
|--------------------------------------|------|--------|
| (1) Zone temperature                 | AI   |        |
| (2) Zone temperature setpoint adjust | AI   |        |
| (3) Cabinet unit heater start/stop   | DO   |        |
| (4) Supply fan status                | DI   |        |
| (5) Heating coil control valve       | AO   |        |

END OF SECTION

## SECTION 232113 - HYDRONIC PIPING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
  - 1. Pipe and pipe fittings.
  - 2. Valves.
  - 3. Hydronic specialties.
  - 4. Meters and gages.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
  - 1. Pressure-seal fittings.
  - 2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
  - 3. Air control devices.
  - 4. Hydronic specialties.
  - 5. Meters and gages.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Welding certificates.
- C. Field quality-control test reports.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

#### 1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Differential Pressure Meter: For each type of balancing valve, furnish flowmeter, probes, hoses, flow charts, and carrying case.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
  - 1. Installers of Pressure-Sealed Joints: Installers shall be certified by the pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
- B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

## PART 2 PRODUCTS

### 2.1 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. Wrought-Copper Fittings: ASME B16.22.
- D. Copper or Bronze Pressure-Seal Fittings:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. [Stadler-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.

### 2.2 STEEL PIPE AND FITTINGS

- A. Steel Pipe: Schedule 40 ASTM A 53/A 53M, black steel.
- B. Grooved Mechanical-Joint Fittings and Couplings: Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. Mechanical Coupling bolts shall be zinc plated heat treated carbon steel track head conforming to ASTM A-449 and, minimum tensile strength 110,000 psi.
  - 1. Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1 Installation ready rigid coupling for direct stab installation without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red and green color code designed for operating temperatures from -30° F to +250° F. Basis of design: Victaulic S/107N, S/W07

2. Flexible Type: Use in locations where vibration attenuation and thermal expansion compensation (including risers) are required. Three flexible couplings may be used in lieu of flex connectors. Installation ready flexible coupling for direct stab installation without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red and green color code designed for operating temperatures from -30° F to +250° F. Basis of Design: Victaulic S/177N S/W77
3. Fittings: Cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, provided with an alkyd enamel finish. Factory-fabricated grooved end header all-in-one assembly for fluid distribution, consisting of an ASTM A53, Grade B, standard weight pipe spool with required outlet connections. Grooved ends roll grooved to Victaulic dimensions, with enamel coating.

## 2.3 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
  1. Description:
    - a. Standard: ASSE 1079.
    - b. Pressure Rating: 125 psig minimum at 180 deg F.
    - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
  1. Description:
    - a. Standard: ASSE 1079.
    - b. Factory-fabricated, bolted, companion-flange assembly.
    - c. Pressure Rating: 125 psig minimum at 180 deg F.
    - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

## 2.4 BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
  1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO Model S-585-70-66 or T-585-70-66 or a comparable product by one of the following:
    - a. Conbraco Industries, Inc.; Apollo Div.
    - b. Jamesbury, Inc.
  2. Description:
    - a. Standard: MSS SP-110.
    - b. SWP Rating: 150 psig.
    - c. CWP Rating: 600 psig.

- d. Body Design: Two piece with threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing.
- e. Body Material: Bronze ASTM B 584 Alloy C844.
- f. Ends: Threaded or Solder.
- g. Seats: PTFE or TFE.
- h. Stem: 316 stainless steel.
- i. Ball: 316 stainless steel, vented.
- j. Port: Full.

## 2.5 DUCTILE IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO Model LD-2000-3/5 & LD-1000-5, or a comparable product by one of the following:
    - a. Cooper Cameron Corp.; Cooper Cameron Valves Div.
    - b. Tyco International, Ltd.; Tyco Valves & Controls
  - 2. Description:
    - a. Standard: MSS SP-67, Type I.
    - b. NPS 12 and Smaller CWP Rating: 200 psig.
    - c. NPS 14 and Larger CWP Rating: 150 psig.
    - d. Body Design: Full Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
    - e. Body Material: ASTM A 536, ductile iron.
    - f. Seat: EPDM.
    - g. Stem: One- or two-piece stainless steel.
    - h. Disc: Aluminum bronze.

## 2.6 DUCTILE IRON, GROOVED-END BUTTERFLY VALVES

- A. 300 CWP, Iron, Grooved-End Butterfly Valves with EPDM Disc:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO Model GD-4765-3/5, or a comparable product by one of the following:
    - a. Victaulic Company.
  - 2. Description:
    - a. Standard: MSS SP-67, Type I.
    - b. NPS 8 and Smaller CWP Rating: 300 psig.
    - c. NPS 10 and Larger CWP Rating: 200 psig.
    - d. Body Material: Polyamide Coated, ductile iron ASTM A 395.
    - e. Stem: Two-piece stainless steel.
    - f. Disc: EPDM-Encapsulated, ductile iron.
    - g. Seal: EPDM.



## 2.7 BRONZE LIFT CHECK VALVES

- A. Class 125, Lift Check Valves with Nonmetallic TFE Disc:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO Model S-480-Y or T-480-Y or a comparable product by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Powell Valves.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 2.
    - b. CWP Rating: 250 psig (1725 kPa).
    - c. Body Design: Vertical flow.
    - d. Body Material: ASTM B 584 Alloy C844, bronze.
    - e. Ends: Threaded or Solder.
    - f. Disc: PTFE, or TFE.

## 2.8 IRON, CENTER-GUIDED CHECK VALVES

- A. Class 125, Iron, Globe, Center-Guided Check Valves with Resilient Seat:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO Model F-910-B, or a comparable product by one of the following:
    - a. Metraflex Co.
    - b. Val-Matic Valve & Manufacturing Corp.
  - 2. Description:
    - a. Standard: MSS SP-125, FCI 74-1 and MIL-V-18436F.
    - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).
    - c. Body Material: ASTM A 48, gray iron.
    - d. Style: Globe, spring loaded.
    - e. Ends: Flanged.
    - f. Seat: Buna-N.

## 2.9 IRON, PLATE-TYPE CHECK VALVES

- A. Class 125, Iron, Single-Plate Check Valves with Resilient Seat:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide NIBCO Model W-920-W, or a comparable product by one of the following:
    - a. Metraflex Co.
    - b. Val-Matic Valve & Manufacturing Corp.
    - c. Victaulic
  - 2. Description:
    - a. Standard: ANSI B 16.1.
    - b. NPS 2-1/2 to NPS 12 (DN 65 to DN 300), CWP Rating: 200 psig (1380 kPa).

- c. Body Design: Wafer, spring-loaded plate.
- d. Body Material: ASTM A 126, gray iron.
- e. Seat: Buna-N.

## 2.10 BALANCING VALVES

### A. Bronze, Calibrated-Orifice, Balancing Valves:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. [Armstrong Pumps, Inc.](#)
  - b. [Bell & Gossett Domestic Pump; a division of ITT Industries.](#)
  - c. [Taco.](#)
  - d. Tour & Andersson
- 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.

## 2.11 AIR CONTROL DEVICES

### A. [Manufacturers](#): Subject to compliance with requirements, provide products by one of the following:

- 1. [Amtrol, Inc.](#)
- 2. [Armstrong Pumps, Inc.](#)
- 3. [Bell & Gossett Domestic Pump; a division of ITT Industries.](#)
- 4. [Taco.](#)

### B. Manual Air Vents:

- 1. Body: Bronze.
- 2. Internal Parts: Nonferrous.
- 3. Operator: Screwdriver or thumbscrew.
- 4. Inlet Connection: NPS 1/2.
- 5. Discharge Connection: NPS 1/8.
- 6. CWP Rating: 150 psig.
- 7. Maximum Operating Temperature: 225 deg F.

### C. Automatic Air Vents:

1. Body: Bronze or cast iron.
2. Internal Parts: Nonferrous.
3. Operator: Noncorrosive metal float.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/4.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 240 deg F.

D. Bladder-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

E. Tangential-Type Air Separators:

1. Tank: Welded steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature.
2. Air Collector Tube: Perforated stainless steel, constructed to direct released air into expansion tank.
3. Tangential Inlet and Outlet Connections: Threaded for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger.
4. Blowdown Connection: Threaded.
5. Size: Match system flow capacity.

## 2.12 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: 40 -mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
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. Grooved End Strainers

1. T-Type Strainer. 2" through 12" sizes, 300 PSI T-Type Strainer shall consist of ductile iron (ASTM A-536, Grade 65-45-12) body, Type 304 stainless steel frame and mesh removable basket with No. 12 mesh, 2"-3" strainer sizes, or No. 6 mesh, 4"-12" strainer sizes, 57% free open area. Victaulic Style 730.
2. Y-Type Strainer. 2" through 18" sizes, 300 PSI Y-Type Strainer shall consist of ductile iron body, ASTM A-536, Grade 65-45-12, Type 304 stainless steel perforated metal removable baskets with 1/16" diameter perforations 2"-3" strainer sizes, 1/8" diameter perforations 4"-12" strainer sizes, and 0.156" diameter perforations 14" -18" strainer sizes. Victaulic Style 732 and W732.

D. 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.

## 2.13 METERS AND GAGES

A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Ashcroft Inc., Terrice, H. O. Co., Weiss Instruments, Inc.
2. Standard: ASME B40.200.
3. Case: Sealed type, cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Element: Bourdon tube or other type of pressure element.
5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
6. Dial: Non-reflective aluminum with permanently etched scale markings graduated in deg F.
7. Scale Range for Heating Hot Water Piping: 30 to 240 deg F.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless steel.
11. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
12. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
13. Accuracy: Plus or minus 1 percent of scale range.

- B. 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.
  - 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.
- C. Heat-Transfer Medium: Mixture of graphite and glycerin.
- D. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: AMETEK, Inc.; U.S. Gauge; Ashcroft Inc.; Trerice, H. O. Co.; Weiss Instruments, Inc.; WIKA Instrument Corporation - USA.
  - 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, 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. Scale Range for Heating Hot Water Piping: 0 to 100 psi.
  - 9. Pointer: Dark-colored metal.
  - 10. Window: Glass.
  - 11. Ring: Stainless steel.
  - 12. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
- E. Gage Attachments
  - 1. Snubbers: ASME B40.100, brass; with NPS 1/4, ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
  - 2. Valves: Ball valve NPS 1/4.
- F. Test Plugs

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Flow Design, Inc.; Peterson Equipment Co., Inc.; Trerice, H. O. Co.; Weiss Instruments, Inc.
  2. Description: Test-station fitting made for insertion into piping tee fitting.
  3. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
  4. Thread Size: NPS 1/4, ASME B1.20.1 pipe thread.
  5. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
  6. Core Inserts: EPDM self-sealing rubber.
- G. Test-Plug Kits
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Flow Design, Inc.; Peterson Equipment Co., Inc.; Trerice, H. O. Co.; Weiss Instruments, Inc.
  2. Furnish two (2) test-plug kits containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
  3. Low-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 25 to 125 deg F.
  4. 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.
  5. 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.
  6. Carrying Case: Metal or plastic, with formed instrument padding.

## PART 3 EXECUTION

### 3.1 PIPING APPLICATIONS

- A. Aboveground, NPS 2.5 and smaller, shall be the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and pressure-seal joints.
- B. Aboveground, NPS 3 and larger, shall be the following:
1. Schedule 40 black steel with grooved fittings and mechanical couplings.
- C. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

### 3.2 VALVE APPLICATIONS

- A. Install shut off-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- B. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.

### 3.3 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. 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 branch connections to mains using [mechanically formed] tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- R. Grooved Joints: Pipe ends shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove for proper gasket sealing. The gasket style and elastomeric material shall be verified as suitable for the intended service as specified. Flexible couplings only to be used for expansion loops, pump trim and where approved by the engineer. A factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation. All groove depths shall be checked manually or by grooving tool (RG5200i). A Victaulic representative shall periodically visit the job site and review installation.
- S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- T. Install sleeves for piping penetrations of walls, ceilings, and floors.

### 3.4 HANGERS AND SUPPORTS

- A. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal piping.
  - 2. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- B. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 3/8 inch.
  - 2. NPS 3: Maximum span, 12 feet; minimum rod size, 3/8 inch.
  - 3. NPS 4: Maximum span, 14 feet; minimum rod size, 1/2 inch.
  - 4. NPS 6: Maximum span, 17 feet; minimum rod size, 1/2 inch.
- C. 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 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
  6. NPS 3: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- D. Support vertical runs at roof, at each floor, and at 8-foot intervals between floors.

### 3.5 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. Manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install tangential air separator in pump suction. Install blowdown piping with gate or full-port ball valve; extend full size to nearest floor drain.
- D. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements.

### 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.

### 3.7 PIPE CLEANING AND INITIAL FILL

- A. Clean piping systems with a 1% to 2% solution of trisodium phosphate in water prior to the installation of heat transfer fluid. Circulate solution for a minimum of 24 hours, drain, and clean strainer screens.
- B. Fill systems indicated to have glycol solutions:
  1. Use water with low levels (less than 25 ppm) of chloride and sulfate, and less than 50 ppm of hard water ions (Ca++, Mg++).
  2. If good quality water is unavailable, purchase pre-diluted solutions of industrially inhibited propylene glycol fluid from the fluid manufacturer or, if available, from the distributor.
  3. Submit water tests from an independent laboratory prior to initial fill.
- C. Upon completion of system commissioning work, submit fluid sample to manufacturer for analysis. Provide report indicating inhibitor and fluid concentrations are satisfactory.

### 3.8 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 of 100 psig or 1.5 times the system working pressure, whichever is greater. 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 "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
  - 5. After hydrostatic test pressure has been applied for at least 15 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.

### 3.9 METERS AND GAGES

- A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
- B. Install thermowells with extension on insulated piping.
- C. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- D. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- E. Install valve and snubber in piping for each pressure gage.
- F. Install test plugs in the following locations:
  1. Inlet and outlet of each hydronic coil.
  2. Inlet and outlet of each terminal unit.
  3. Where indicated on plans and details.

END OF SECTION 232113

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## SECTION 232123 - HVAC PUMPS

### PART 1 GENERAL

#### 1.1 REFERENCE STANDARDS

- A. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications; 2022.

#### 1.2 SUMMARY

- A. Section Includes:
  - 1. Variable Speed Pump Package
    - a. Vertical inline close-coupled pumps.
    - b. Separately coupled, base-mounted, end-suction centrifugal pumps.
    - c. Variable frequency drives.
    - d. TEFC motor.
    - e. Integrated controls.

#### 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.

#### 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 spare mechanical seal for each pump.

#### 1.6 QUALITY ASSURANCE

- A. The pump control package shall be fully assembled by the manufacturer. The manufacturer shall be responsible for the complete pump control package, including system interface with pumps and VFDs, as well as the successful operation of all components supplied by the pump control system manufacturer.
- B. All functions of the variable speed pump control system shall be thoroughly field tested prior to actual start-up. This test shall be conducted with motors connected to AFD output and it shall test all inputs, outputs and program execution specific to this application.
- C. Pump control package shall be listed by Underwriter's Laboratories and bear the UL label.

## 1.7 WARRANTY

- A. Manufacturer's warranty: The entire package shall carry a 18 month parts warranty. The drive will carry a parts and labor warranty. The motor will carry a 12 month parts and labor warranty but must be delivered to a local authorized motor warranty shop by the installing contractor. Manufacturer's warranty is in addition to and not intended to limit other rights Owner may have under Contract Conditions.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide units manufactured by Grundfos Pumps Corporation. or comparable product by one of the following:
  - 1. Bell & Gossett, a Xylem Brand.
  - 2. Taco

### 2.2 MANUFACTURED UNITS

- A. The self-sensing product shall consist of a factory prepackaged and preprogrammed pump, drive, motor, and integral controls package.
- B. The drive shall be mounted and integral to the motor. It shall be mounted with rubber vibration mounts. The mounting and packing of the drive shall be done in a manner that transmitted acceleration levels will be three times below the allowable limits published by the drive manufacturer. These limits will apply to a frequency range of 0-10,000 HZ.

- C. The performance speed of this package shall 1750 RPM nominal as standard. Exceptions for 3600 RPM will be noted in the schedules. 3600 RPM shall NOT be an allowable substitution for a specified 1750 PRM package. 3600 RPM products might be considered as a substitution for 1750 RPM only if that manufacturer provides a spare motor, drive, and seal for each pumping unit.
- D. Pump logic controller, variable frequency drives, sensor/transmitters and related equipment shall be installed by the mechanical contractor as shown on the plans.

### 2.3 Vertical Inline Close-Coupled Pumps.

- A. Basis of Design: Taco Model SKV.
- B. The seal shall be serviceable without disturbing the piping connections.
- C. Pump casing constructed of ASTM A48 class 30 cast iron.
  - 1. Pump casing/volute rated for 250 psi working pressure.
  - 2. ANSI class 125 flanges.
  - 3. Drilled and tapped for gauge ports on both the suction and discharge connections and for a drain port at the bottom of the casing.
  - 4. Additional tapping on the discharge connection to allow for the installation of a seal flush line.
  - 5. The pump cover shall be drilled and tapped to accommodate a seal flush line which can be connected to the corresponding tapping on the discharge connection, or to an external source to facilitate cooling and flushing of the seal faces.
  - 6. The pump shall have a factory installed vent/flush line to insure removal of trapped air from the casing and mechanical seal cooling. The vent/flush line shall run from the seal chamber to the pump discharge.
- D. Impeller: ASTM B584-836/875 bronze and hydraulically balanced.
  - 1. The impeller shall be dynamically balanced to ANSI Grade G6.3 and shall be fitted to the shaft with a key.
- E. Shaft: AISI 416 Stainless Steel shaft.
- F. Seal: single mechanical seal, with EPT elastomers and Carbon/Ceramic faces, rated up to 250°F.
- G. Coupling: The pump shall be close coupled to a JM Frame, TEFC, inverter rated motor with class F insulation and shaft grounding ring.
  - 1. SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS
    - a. [Basis-of-Design Product](#): Subject to compliance with requirements, provide units manufactured by TACO, Inc. or comparable product by one of the following:

- 1) Bell & Gossett, a Xylem Brand.
    - 2) Grundfos Pumps Corporation.
  - b. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal.
  - c. Pump Construction:
    - 1) Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing and provide attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
    - 2) Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For pumps not frequency-drive controlled, trim impeller to match specified performance.
    - 3) Pump Shaft Sleeve: Type 303 stainless steel
    - 4) Pump Shaft: Type 416 stainless steel
    - 5) Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPDM bellows and gasket.
    - 6) Pump Bearings: Grease-lubricated ball bearings in cast-iron housing with grease fittings for lubrication in field.
  - d. Shaft Coupling: Molded-rubber insert capable of absorbing vibration. Spacer couplings to be drop-out type. EPDM coupling sleeve for variable-frequency applications.
  - e. Coupling Guard: Dual rated; ANSI B15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
  - f. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
  - g. Motor: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    - 1) NEMA Premium Efficient motors as defined in NEMA MG 1.
    - 2) 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.
    - 3) Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
    - 4) Variable-speed motor.
    - 5) Provide pump motor variable-frequency controller.
2. PUMP SPECIALTY FITTINGS



- a. Suction Diffuser:
  - 1) Angle pattern.
  - 2) 175-psig pressure rating, ductile-iron body and end cap, pump-inlet fitting.
  - 3) Bronze startup and bronze or stainless-steel permanent strainers.
  - 4) Bronze or stainless-steel straightening vanes.
  - 5) Drain plug.
  - 6) Factory-fabricated support.

## 2.4 PUMP LOGIC CONTROLLER

- A. The controller operation shall operate the system using a tested and proven program that safeguards against undesirable or damaging conditions including:
  - 1. Motor overload
  - 2. Pump flow surges
  - 3. Hydraulic cycling (hunting).
  - 4. End of curve unstable operation: The pump logic controller, through a factory preprogrammed algorithm, shall be capable of protecting the pumps from hydraulic damage due to operation beyond their published end-of-curve. This feature requires a flow meter for activation. The operator interface shall include an owner adjustable flow setpoint to set the parameters for this routine.
- B. The pump logic controller shall be capable of starting, unloading, and stopping pumps based on a system performance program that will minimize energy consumption, provide reliable performance and bumpless transitions.
- C. The integrated logic controller shall be capable of running four different hydronic optimization sub-routines
  - 1. Setup one: This subroutine shall allow the pump package to track a quadratic system curve and will optimize a secondary distribution loop. It shall use a technology that allows the pump, drive, and motor package to translate the hydronic data from both a pump and system curve and translate it to electrical data. This allows the drive to know exactly where it is in the hydronic world.
  - 2. Setup two: This subroutine shall allow two pumps to run as backup for each other and shall alternate the pumps based on a real time clock.
  - 3. Setup three: This subroutine shall allow the package to run in a customer defined flow rate. The package will always seek to run at the user defined flow even with fouling causing system changes. It shall use a technology that allows the pump, drive, and motor package to translate the hydronic data from both a pump and system curve and translate it to electrical data. This allows the drive to know exactly where it is in the hydronic world.

4. Setup four: This subroutine shall incorporate a traditional external sensing and control platform. It shall allow the option of controlling the pumps with three zones of differential pressure or central plant differential temperature. This optional setup shall allow the owner the option of external sensing without adding an external controller. This feature shall be equal to Taco System Logic (TSL) or equal.
5. The control platform shall include a subroutine equal to the Taco Self-Sensing Series with ProBalance™. This subroutine shall allow for the automatic balancing of secondary system distribution pumps. The package shall automatically run system distribution pumps to a user defined duty point and will recognize that duty point and hold the pumps at a speed that matches the actual installed system quadratic system curve. The package will then use this data to set up a new duty point as the max point for the quadratic control curve. Use of external balancing devices or contractors will not be needed.
6. The package shall serve as a flow metering device and will display pump flow at the user interface.
7. Shall have optional ProView controller that automates pump balancing.

## 2.5 VARIABLE FREQUENCY DRIVE

- A. The VFD shall convert incoming fixed frequency three-phase ac power into an adjustable frequency and voltage for controlling the speed of three-phase ac motors. The motor current shall closely approximate a sine wave. Motor voltage shall be varied with frequency to maintain desired motor magnetization current suitable for the driven load and to eliminate the need for motor derating. When properly sized, the VFD shall allow the motor to produce full rated power at rated motor voltage, current, and speed without using the motor's service factor. VFDs utilizing sine weighted/coded modulation (with or without 3rd harmonic injection) must provide data verifying that the motors will not draw more than full load current during full load and full speed operation.
- B. The VFD shall include an input full-wave bridge rectifier and maintain a fundamental (displacement) power factor near unity regardless of speed or load.
- C. The VFD shall have a dual 5% impedance DC link reactor on the positive and negative rails of the dc bus to minimize power line harmonics and protect the VFD from power line transients. The chokes shall be non-saturating. Swinging chokes that do not provide full harmonic filtering throughout the entire load range are not acceptable. VFDs with saturating (non-linear) dc link reactors shall require an additional 3% AC line reactor to provide acceptable harmonic performance at full load, where harmonic performance is most critical.
- D. The VFD's full load output current rating shall meet or exceed nec table 430-150. The VFD shall be able to provide full rated output current continuously, 110% of rated current for 60 seconds and 120% of rated torque for up to 0.5 second while starting.

- E. The VFD shall provide full motor torque at any selected frequency from 20 hz to base speed while providing a variable torque v/hz output at reduced speed. This is to allow driving direct drive fans without high speed derating or low speed excessive magnetization, as would occur if a constant torque v/hz curve was used at reduced speeds. Breakaway current of 160% shall be available.
- F. A programmable automatic energy optimization selection feature shall be provided standard in the VFD. This feature shall automatically and continuously monitor the motor's speed and load to adjust the applied voltage to maximize energy savings.
- G. The VFD must be able to produce full torque at low speed to operate direct drive fans.
- H. Output power circuit switching shall be able to be accomplished without interlocks or damage to the VFD.
- I. An automatic motor adaptation algorithm shall measure motor stator resistance and reactance to optimize performance and efficiency. It shall not be necessary to run the motor or de-couple the motor from the load to perform the test.
- J. Galvanic isolation shall be provided between the VFD's power circuitry and control circuitry to ensure operator safety and to protect connected electronic control equipment from damage caused by voltage spikes, current surges, and ground loop currents. VFDs not including either galvanic or optical isolation on both analog i/o and discrete digital i/o shall include additional isolation modules.
- K. VFD shall minimize the audible motor noise through the use of an adjustable carrier frequency. The carrier frequency shall be automatically adjusted to optimize motor and VFD operation while reducing motor noise. VFDs with fixed carrier frequency are not acceptable.
- L. All VFDs shall contain integral EMI filters to attenuate radio frequency interference conducted to the ac power line.
- M. The drive enclosure shall be standard as NEMA 12 (IP 55) and optional shall be NEMA 4X (IP 66).
- N. Internal Control Algorithm
  - 1. This is a standard HVAC drive that has been upgraded and modified by pump experts for Hydronic applications. It is set up with a closed loop internal control sequence that will optimize life cycle, system comfort, and minimize energy consumption.
- O. Interface Features
  - 1. Hand, off and auto keys shall be provided to start and stop the VFD and determine the source of the speed reference. It shall be possible to either disable these keys or password protect them from undesired operation.

- P. Standard Control and Monitoring Inputs and Outputs
  - 1. Six dedicated, programmable digital inputs shall be provided for interfacing with the systems control and safety interlock circuitry.
- Q. Optional Control and Monitoring Inputs and Outputs
  - 1. It shall be possible to add optional modules to the VFD in the field to expand its analog and digital inputs and outputs
- R. A real-time clock shall be an integral part of the VFD.
  - 1. It shall be possible to use this to display the current date and time on the VFD's display.
- S. The VFD shall be able to store load profile data to assist in analyzing the system demand and energy consumption over time.
- T. The VFD shall include a sequential logic controller to provide advanced control interface capabilities. This shall include:
  - 1. Comparators for comparing VFD analog values to programmed trigger values
- U. The VFD shall include a cascade controller which allows the VFD to operate in closed loop setpoint (PID) control mode one motor at a controlled speed and control the operation of 3 additional constant speed motor starters.
- V. Serial communications
  - 1. The VFD shall include a standard eia-485 communications port and capabilities to be connected to the following serial communication protocols at no additional cost and without a need to install any additional hardware or software in the VFD:
    - a. Johnson Controls Metasys N2
    - b. Modbus RTU
    - c. Siemens FLN
    - d. BACnet MS/TP
    - e. Optional communication shall include:
    - f. LonWorks Free Topology (FTP)
  - 2. VFD shall have standard USB port for direct connection of Personal Computer (PC) to the VFD. The manufacturer shall provide no-charge pc software to allow complete setup and access of the VFD and logs of VFD operation through the USB port. It shall be possible to communicate to the VFD through this USB port without interrupting VFD communications to the building management system.
  - 3. The VFD shall have provisions for an optional 24 v DC back-up power interface to power the VFD's control card. This is to allow the VFD to continue to communicate to the building automation system even if power to the VFD is lost.

## 2.6 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser:

1. Ductile iron body.
2. Angle pattern.
3. Pump connection size to match pump flange size.
4. System connection size to match pipe size.
5. Gauge port at system connection flange, 1/4" NPT.
6. 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting.
7. Class 125 flanges.
8. Bronze startup and stainless-steel permanent strainers with magnetic insert.
9. Straightening vanes.
10. Blowdown port.

### PART 3 EXECUTION

#### 3.1 PUMP INSTALLATION

- A. Comply with manufacturer's instructions.
- B. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- C. Independently support piping so weight of piping is not supported by pumps.

#### 3.2 CONNECTIONS

- A. Where installing piping adjacent to pump, allow space for service and maintenance.
- B. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- C. Install suction and discharge pipe sizes as indicated on drawings. Provide increasers/reducers as close as practical to pump flanges.
- D. Install shutoff valves and non-slam check valves on discharge side of pumps.
- E. Install shutoff valve on suction side of pumps.
- F. All pumps shall be fitted with one 4½-inch dial pressure gauge piped to the inlet and outlet pump flanges and inlet of suction diffuser where applicable. The gauge is to be isolated from each flange via 1/4" ball valve.
- G. Install suction diffuser and shutoff valve on suction side of vertical in-line and base-mounted pumps.
- H. Change start-up strainers to permanent strainer upon acceptance of the work. Provide a blowdown valve on each strainer and terminate with hose thread or extend blowdown line to nearest floor drain.

#### 1. 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.

### 3.3 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.

### 3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train 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 SUMMARY

- A. This section specifies cleaning and treatment of circulating HVAC water systems, including the following.
  - 1. Cleaning compounds.
  - 2. Chemical treatment for closed loop hydronic systems.
  - 3. Water treatment equipment.

#### 1.2 SCOPE

- A. Drain and flush clean the existing hot water system in Currier Hall prior to putting the new pumps and heat exchanger into service. Flush, fill and treat hot water system per the requirements indicated in this specification. Do not drain the existing system and leave empty for an extended period. Flushing and filling should occur right after draining of the system.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Minimize corrosion, scale buildup, and biological growth for optimum efficiency of mechanical equipment without creating a hazard to operating personnel or the environment.
- B. Base water treatment program on quality of water available at project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. Chemically treat and maintain closed-loop hydronic system water to meet following standards:
  - 1. Suspended solids: None.
  - 2. stable rate, 0.5 mils per year maximum, no pitting.
  - 3. stable rate, 0.2 mils per year maximum, no pitting.
  - 4. 0.5 mg/L Fe maximum.
  - 5. 0.2 mg/L Cu maximum.
  - 6. pH: 8.5 – 9.5, accuracy  $\pm 0.1$
  - 7.  $<2500 \text{ } \mu\text{S/cm}$  (micro siemens/cm)
  - 8. "P" Alkalinity: Maintain a value within 100 to 500 ppm.
  - 9. Boron: Maintain a value within 100 to 200 ppm.

10. Chemical Oxygen Demand: Maintain a maximum value of 100 ppm.
11. TDS: Maintain a maximum value of 10 ppm.
12. Microbiological Limits:
  - a. Total Aerobic Plate Count: Maintain a maximum value of 1000 organisms/ml.
  - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/ml.
  - c. Nitrate Reducers: Maintain a maximum value of 100 organisms/ml.
  - d. Sulfate Reducers: Maintain a maximum value of 0 organisms/ml.
  - e. Iron Bacteria: Maintain a maximum value of 0 organisms/ml.

#### 1.4 ACTION SUBMITTALS

- A. Product data for each type of chemical supplied. Include manufacturer's technical product data, material safety data sheets and manufacturer's instructions for proper application of chemicals.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.
- B. Field test reports indicating and interpreting test results relative to compliance with specified requirements.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operations and Maintenance Manual: Include the following:
  1. Material Safety Data Sheets for chemical supplied.
  2. Manufacturer's instructions for proper application of chemicals.
  3. Maintenance schedules for application and testing.

#### 1.7 QUALITY ASSURANCE

- A. Supplier Qualifications: A recognized chemical water treatment supplier with warehousing facilities in the Project's vicinity and that is or employs an experienced consultant, available at reasonable times during the course of the Work to consult with Contractor, Architect, and Owner about water treatment.
- B. Chemical Standards: Meet state and local environmental regulations.

#### 1.8 QUALIFICATIONS



- A. Water treatment company specializing in performing the work specified in this Section with minimum five years experience. Company shall be capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

#### 1.9 REGULATORY REQUIREMENTS

- A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and to public sewage systems.

#### 1.10 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions for a period of one year from date of Substantial Completion.
  - 1. Provide technical service visits to perform field inspections and make water analysis on site six months and eleven months after completion. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit two copies of field service report after each visit.
  - 2. Provide laboratory and technical assistance services during this maintenance period.
  - 3. Include two hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start up of systems.
  - 4. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

### PART 2 PRODUCTS

#### 2.1 CLEANING CHEMICALS

- A. Cleaning Solution: neutral pH cleaning solution which is capable of removing oil, grease, and rust from metal surfaces of system and passivating cleaned metal surfaces of system. Cleaning solution shall include:
  - 1. Low foaming non-ionic surfactant for penetrating oily and greasy deposit surfaces.
  - 2. Solvent for dissolving oil and grease.
  - 3. Dispersant for dissolving rust.
  - 4. Reducing agent for corrosion control.
  - 5. Ferrous and non-ferrous metal corrosion inhibitors.
- B. All chemicals to be acceptable for discharge to sanitary sewer.

## 2.2 TREATMENT CHEMICALS

- A. Furnish chemicals recommended by water treatment system manufacturer for treating water to meet specified water quality. Provide only chemicals that are compatible with piping materials, seals, and accessories.

## 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: 175 psig.
- B. Provide test kits for all treatment programs.

## 2.4 CHEMICAL TREATMENT TEST EQUIPMENT

- A. Provide white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titrating burettes and associated reagents.
  - 1. Provide test kits for all treatment programs.
- B. Corrosion Test-Coupon Assembly: Two station rack constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.

## PART 3 EXECUTION

### 3.1 WATER ANALYSIS

- A. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to maintain the water quality as specified in "Performance Requirements" Article.

### 3.2 INSTALLATION

- A. Install treatment equipment level and plumb, in accordance with manufacturer's instructions.
- B. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.

- C. Provide 3/4 inch water coupon rack around circulating pumps. Maintain access to coupon rack.
- D. Install piping adjacent to equipment to allow service and maintenance.

### 3.3 CLEANING - GENERAL

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.
- C. Manual and automatic valves are in full open position.
- D. By-pass valves are operated to ensure full flow through entire system.
- E. Safety devices, including pressure relief valves, flow switches, and pressure switches are functioning.
- F. Temporary fine mesh strainers for system pump and control valve strainer baskets are installed and cleaned as required.

### 3.4 CLEANING PROCEDURE

- A. Step 1: Fill system with domestic water, establish circulation, and heat system contents to a temperature of 140°F.
- B. Step 2: After two hours of circulation, collect water samples from at least three different locations in system. If these samples contain suspended solids, clean out strainer baskets, drain system, and repeat steps 1 & 2.
- C. Step 3: Blend in prepared concentrated cleaning solution, establish circulation, and maintain system temperature at 140°F for at least three days.
- D. Step 4: Dump spent cleaning solution to disposal, fill system with domestic water, circulate system contents for at least two hours, and dump spent rinse water to disposal.
- E. Step 5: Fill system with domestic water and repeat step 4 until water samples collected from system are free of oil, grease, and suspended solids.
- F. Step 6: Drain system completely, including all system low points and perform visual inspections of metal surfaces at three different locations.
- G. Complete steps 4, 5 & 6 within a 24 hour period.
- H. If metal surfaces contain oil/grease or silt, fill the system with domestic water and repeat steps 3, 4, 5 & 6.

- I. Immediately after inspection is completed, install strainers, fill system with domestic water, blend in concentrated corrosion inhibitor solution until its concentration in system is at an acceptable level for film formation, and pass system water through corrosion coupon rack.

### 3.5 ADJUSTING

- A. Sample water at two-week intervals after each system startup for a period of three months, and prepare certified test report for each required water performance characteristic. Where applicable, comply with industry standard test procedures.

### 3.6 DEMONSTRATION

- A. Provide services of water treatment firm's representative for half a day to instruct Owner's personnel in operation, maintenance, and testing procedures of chemical water treatment system.
- B. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
  1. Review manufacturer's safety data sheets for handling of chemicals.
  2. Review data in maintenance manuals, especially data on recommended parts inventory and supply sources and on availability of parts and service. Refer to Division 01 Section Closeout Procedures.

END OF SECTION

## SECTION 233113 - METAL DUCTWORK

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Single-wall rectangular ducts and fittings.
  - 2. Single-wall round ducts and fittings.
  - 3. Sheet metal materials.
  - 4. Sealants and gaskets.
  - 5. Hangers and supports.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of the following products:
  - 1. Liners and adhesives.
  - 2. Sealants and gaskets.
  - 3. Factory fabricated ducts and fittings.
- B. Shop Drawings:
  - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
  - 2. Shop fabricated ducts and fittings.
  - 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
  - 4. Elevation of top of ducts.
  - 5. Dimensions of main duct runs from building grid lines.
  - 6. Fittings.
  - 7. Reinforcement type and spacing.
  - 8. Seam and joint construction.
  - 9. Penetrations through fire-rated and other partitions.
  - 10. Equipment installation based on equipment being used on Project.
  - 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
  - 12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which ducts will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
  - a. Lighting fixtures.
  - b. Air outlets and inlets.
  - c. Speakers.
  - d. Fire alarm devices.
  - e. Sprinklers.
  - f. Access panels.

#### 1.4 DELIVERY, STORAGE and HANDLING

- A. Deliver products to the Project Site and store in dry, covered and protected location. Do not store products outdoors.
- B. Protect materials from rust both before and after installation. Ductwork and fittings shall be sealed from dirt and debris.

#### 1.5 WARRANTY

- A. All ductwork systems shall be constructed and erected in a first class workmanlike manner.
- B. The Work shall be guaranteed for a period of one (1) year from the Project Substantial Completion date against noise, chatter, whistling, vibration, and free from pulsation under all conditions of operation. After the system is in operation, should these defects occur, they shall be corrected as directed by the Owner at Contractor's expense.

### 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, provide products by one of the following :
    - a. Lindab Inc.
    - b. McGill AirFlow LLC.
    - c. SEMCO Incorporated.
- 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 30 inches diameter shall be flanged type.
- 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."

- 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. 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.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90.
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- D. 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. Solvent-Based Joint and Seam Sealant:
  - 1. Application Method: Brush on.
  - 2. Base: Synthetic rubber resin.
  - 3. Solvent: Toluene and heptane.
  - 4. Solids Content: Minimum 60 percent.
  - 5. Shore A Hardness: Minimum 60.
  - 6. Water resistant.
  - 7. Mold and mildew resistant.
  - 8. Maximum Static-Pressure Class: 10-inch wg, positive or negative.
  - 9. Service: Indoor or outdoor.
- C. 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.
- D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.
- E. 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 Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. 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.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. 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. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

### 3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

### 3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

### 3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Penetration of the concrete slab is not permitted.
- 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.

### 3.5 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 23 33 00.
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.6 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.

### 3.7 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
- B. Supply Ducts:
  - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and similar terminal unit equipment less than 2,000 cfm capacity.
    - a. Pressure Class: Positive 2-inch wg.
    - b. Minimum SMACNA Seal Class: B.
  - 2. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive 3-inch wg.
    - b. Minimum SMACNA Seal Class: A.
  - 3. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive 2-inch wg.
    - b. Minimum SMACNA Seal Class: A.
- C. Return Ducts:
  - 1. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and similar terminal unit equipment less than 2,000 cfm capacity.
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: B.
  - 2. Ducts Connected to Air-Handling Units:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: B.
  - 3. Ducts Connected to Equipment Not Listed Above:
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: A.
- D. Exhaust Ducts:
  - 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
    - a. Pressure Class: Negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
  - 2. Ducts Connected to Air-Handling Units :
    - a. Pressure Class: Positive or negative 2-inch wg.
    - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Air-Handling Units :
  - a. Pressure Class: Positive or negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: A.
- F. 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.
    - b. Velocity 1000 to 1500 fpm:
      - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      - 2) 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) 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. 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: Welded.
- G. 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: 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 SUMMARY

- A. Section Includes:
  - 1. Manual volume dampers.
  - 2. Fire dampers.
  - 3. Smoke dampers.
  - 4. Duct-mounted access doors.
  - 5. Flexible connectors.
  - 6. Flexible ducts.
  - 7. Duct accessory hardware.

#### 1.2 ACTION SUBMITTALS

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

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

#### 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. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

#### 1.5 QUALITY ASSURANCE

- 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 AMCA 500-D testing for damper rating.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

- A. 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.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G90.
  - 2. Exposed-Surface Finish: Mill phosphatized.
- 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.

## 2.2 MANUAL VOLUME DAMPERS

- A. Gasketed duct fitting with balancing damper for use in systems where a complete shut-off airflow is not required.
  - 1. Gasketed shaft-mounted load bearing bushing to minimize air leakage.
  - 2. Integral blade-shaft assembly.
  - 3. 2-inch sheet metal insulation stand-off collar.
  - 4. Locking blade quadrant with damper position indicator.
  - 5. Lindab DSU or approved equal.

## 2.3 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Air Balance Inc.; a division of Mestek, Inc.
  - 2. Nailor Industries Inc.
  - 3. Ruskin Company.
- B. Type: Static; rated and labeled according to UL 555 by an NRTL.
- C. Fire Rating: 1-1/2 hours.
- D. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- E. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
  - 1. Minimum Thickness: 0.052 or 0.138-inch-thick, as indicated, and of length to suit application.
  - 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.



- F. Mounting Orientation: Vertical or horizontal as indicated.
- G. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- H. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- I. Heat-Responsive Device: Replaceable, 165°F rated, fusible links.

## 2.4 SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Air Balance Inc.; a division of Mestek, Inc.
  - 2. Nailor Industries Inc.
  - 3. Ruskin Company.
- B. General Requirements: Label according to UL 555S by an NRTL.
- C. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- D. Blades: Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- E. Leakage: Class I.
- F. Rated pressure and velocity to exceed design airflow conditions.
- G. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application.
- H. Damper Motors: two-position action.
- I. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  - 2. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
  - 3. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

4. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
5. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
6. Electrical Connection: 115 V, single phase, 60 Hz .

## 2.5 COMBINATION FIRE AND SMOKE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Air Balance Inc.; a division of Mestek, Inc.
  2. Nailor Industries Inc.
  3. Ruskin Company.
- B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- D. Fire Rating: 1-1/2 hours.
- E. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel, with interlocking, gusseted corners and mounting flange.
- F. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- G. Blades: Roll-formed, horizontal, interlocking, 0.063-inch-thick, galvanized sheet steel.
- H. Leakage: Class I.
- I. Rated pressure and velocity to exceed design airflow conditions.
- J. Mounting Sleeve: Factory-installed, 0.05-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.
- K. Damper Motors: two-position action.
  1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  2. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
  3. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.

4. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
5. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.
6. Electrical Connection: 115 V, single phase, 60 Hz.

L. Accessories:

1. Auxiliary switches for signaling, fan control and position indication.
2. Test and reset switches, remote mounted.

## 2.6 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
  2. Nexus PDQ; Division of Shilco Holdings Inc.
  3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

## 2.7 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
  2. Duro Dyne Inc.
  3. METALAIRE, Inc.
  4. SEMCO Incorporated.
  5. 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.
1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

- D. 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."
- E. Vane Construction: Single wall for ducts up to 24 inches wide and double wall for larger dimensions.

## 2.8 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries, Inc.
  - 2. McGill AirFlow LLC.
  - 3. Nailor Industries Inc.
  - 4. 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-inch butt 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 and two sash locks.
    - c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside and inside handles.
    - d. Access Doors Larger than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

## 2.9 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries, Inc.
  - 2. Duro Dyne Inc.
  - 3. Ventfabrics, Inc.
  - 4. 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 2 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.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
  - 1. Minimum Weight: 24 oz./sq. yd.
  - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
  - 3. Service Temperature: Minus 50 to plus 250 deg F.
- G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
  - 1. Minimum Weight: 16 oz./sq. yd.
  - 2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
  - 3. Service Temperature: Minus 67 to plus 500 deg F.
- H. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
  - 1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
  - 2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
  - 7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

## 2.10 FLEXIBLE DUCTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of 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, 2-ply vinyl film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
  2. Maximum Air Velocity: 4000 fpm.
  3. Temperature Range: Minus 10 to plus 160 deg F.
  4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
- C. Flexible Duct Connectors:
1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

## 2.11 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 control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.
- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
1. Install steel volume dampers in steel ducts.
  2. Install aluminum volume dampers in aluminum ducts.

- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire and smoke dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. On both sides of duct coils.
  - 2. Upstream from duct filters.
  - 3. At outdoor-air intakes and mixed-air plenums.
  - 4. At drain pans and seals.
  - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
  - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
  - 7. At each change in direction and at maximum 50-foot spacing.
  - 8. Upstream from turning vanes.
  - 9. Upstream or downstream from duct silencers.
  - 10. Control devices requiring inspection.
  - 11. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
  - 1. One-Hand or Inspection Access: 8 by 5 inches.
  - 2. Two-Hand Access: 12 by 6 inches.
  - 3. Head and Hand Access: 18 by 10 inches.
  - 4. Head and Shoulders Access: 21 by 14 inches.
  - 5. Body Access: 25 by 14 inches.
  - 6. Body plus Ladder Access: 25 by 17 inches.
- K. Install flexible connectors to connect ducts to equipment.
- L. Connect terminal units to supply ducts directly or with maximum 36 inch lengths of flexible duct. Do not use flexible ducts to change directions.
- M. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

### 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. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
  - 4. Inspect turning vanes for proper and secure installation.
  - 5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300



## SECTION 233423 - POWER VENTILATORS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Centrifugal roof ventilators.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Also include the following:
  - 1. Fan performance curves with system operating conditions indicated.
  - 2. Fan sound-power ratings.
  - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
  - 4. Material thickness and finishes, including color charts.
  - 5. Dampers, including housings, linkages, and operators.
  - 6. Roof curbs.
  - 7. Fan speed controllers.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For power ventilators 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. AMCA Compliance: Fans shall have AMCA-Certified performance ratings and shall bear the AMCA-Certified Ratings Seal.
- C. UL Standards: Power ventilators shall comply with UL 705.

#### 1.5 COORDINATION

- A. Coordinate size and location of structural-steel support members.
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

## PART 2 PRODUCTS

### 2.1 CENTRIFUGAL ROOF VENTILATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Greenheck Fan Corporation. (Basis of Design)
  - 2. Loren Cook Company.
  - 3. PennBarry.
  - 4. Twin City Fan.
- B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
  - 1. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.
- C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- D. Direct Drive
- E. Accessories:
  - 1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
  - 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
  - 3. Dampers: Counterbalanced, parallel-blade, motorized backdraft dampers with damper end switches mounted in curb base; factory set to close when fan stops.
- F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base. Provide with curb seal between fan and roof curb.
  - 1. Configuration: Self-flashing without a cant strip, with mounting flange.
  - 2. Overall Height: 24 inches.
  - 3. Metal Liner: Galvanized steel.
- G. Fan Speed Controller: Provide with factory programmed, mounted and wired fan speed controller capable of remote control. Controller shall have integrated 24V transformer or contractor must provide separate 24V transformer as required. If controller cannot fit under fan hood, contractor shall be responsible for mounting of controller and any associated field wiring.
  - 1. Capable of receiving 0-10VDC signal from Building Automation System for remote fan speed control.

### 2.2 MOTORS

- A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."
  - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
  - 2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.
- B. Enclosure Type: Totally enclosed, fan cooled.
- C. Electronically Commutated Motor
  - 1. Motor enclosures: Open type
  - 2. Motor to be a DC electronic commutation type motor (ECM) specifically designed for fan applications. AC induction type motors are not acceptable. Examples of unacceptable motors are: Shaded Pole, Permanent Split Capacitor (PSC), Split Phase, Capacitor Start and 3 phase induction type motors.
  - 3. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and pre-wired to the specific voltage and phase.
  - 4. Internal motor circuitry to convert AC power supplied to the fan to DC power to operate the motor.
  - 5. Motor shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted at the motor or by a 0-10 VDC signal.
  - 6. Motor shall be a minimum of 85% efficient at all speeds.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

- A. Install power ventilators level and plumb.
- B. Secure roof-mounted fans to roof curbs with cadmium-plated hardware. Comply with Division 7 requirements.

#### 3.2 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 23 05 93 for testing, adjusting, and balancing procedures.
- C. Replace fan and motor pulleys as required to achieve design airflow.
- D. Lubricate bearings.

END OF SECTION

## SECTION 233713 - REGISTERS, GRILLES AND DIFFUSERS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Scope of work is indicated by drawings and by requirements of this section.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:
  - 1. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.
  - 2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.
  - 3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.
- B. Samples: When requested by the Engineer, submit one (1) sample of each diffuser, register and grille specified. Samples will not be returned.

#### 1.3 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 2 PRODUCTS

#### 2.1 APPROVED MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide registers, grilles and diffusers from the following list of approved manufacturers:
  - 1. Krueger.
  - 2. Nailor.
  - 3. Price.
  - 4. Titus.
- B. Substitutions: Prior approval required as indicated under the general and/or supplemental conditions of these specifications.

## 2.2 GENERAL

- A. Provide registers, grilles and diffusers having capacities, characteristics and accessories as indicated on the Drawings and specified in this Section.
- B. Provide registers, grilles and diffusers having border types and mounting characteristics compatible with ceiling, wall and floor construction. Refer to Architectural Drawings for materials and methods of construction.

## 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.

### 3.2 INSTALLATION

- A. Unless otherwise shown or specified, install the Work of this section in accordance with the manufacturer's printed installation instructions and applicable SMACNA Standards.
- B. Visible ductwork behind registers shall be painted using one coat of flat black metal paint after proper cleaning.
- C. Install diffusers, registers, and grilles level and plumb.
- D. 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.
- E. 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

## SECTION 235133 - INSULATED SECTIONAL CHIMNEYS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Listed building-heating-appliance chimneys.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for product.
- B. Shop Drawings: For chimneys and stacks.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Detail fabrication and assembly of hangers and seismic restraints.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Sample Warranty: For special warranty.

#### 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 D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in stacks.
- B. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations. The inner diameter of the exhaust system shall be verified by the manufacturer's venting computations. The computations submitted shall follow ASHRAE calculation methods and shall incorporate the specific flow characteristics of the inner pipe. The contractor shall furnish the exact operating characteristics of all appliances to the factory representative.

#### 1.5 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, structural failures caused by expansion and contraction.
  - 2. Warranty Period: 15 years from date of Substantial Completion.
- B. The exhaust system shall be furnished by a vendor organization that assures design, installation and services coordination. As well as, providing "in-warranty" and "post-warranty" unified responsibility for owner, architect, consulting engineer and contractor.

## PART 2 PRODUCTS

### 2.1 LISTED BUILDING-HEATING-APPLIANCE CHIMNEYS

- 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. DuraVent.
  - 2. Selkirk Corporation.
  - 3. Van-Packer.
- B. Description: Double-wall metal vents tested according to UL 103 and rated for 1000 deg F (538 deg C) continuously or 1700 deg F (926 deg C) for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.
- C. Construction: Inner shell and outer jacket separated by at least a 2-inch (50-mm) (75-mm) (100-mm) annular space filled with high-temperature, wool insulation.
- D. Inner Shell: ASTM A 666, Type 316 stainless steel, 0.035 thick.
- E. Outer Jacket: Galvalume, 0.024 inch thick.
- F. Inner wall shall have an overlapping male/female socket that protects the rolled flange with sealant against condensate and high-pressure cleaning. The joints shall be secured with overlapping V or U band on the inner and overlapping locking band on the outer jacket.
- G. System shall be designed to compensate for all temperature induced thermal expansion, installed to be gastight, and thus prevent leakage of combustion products into a building.
- H. The inner wall (flue) shall be laser or plasma welded.
- I. All section joints shall have a self-centering sleeve to ensure proper alignment at the inner wall (flue).



- J. All section joints are connected and sealed with a factory supplied locking band at the inner wall (flue) only. Use appropriate sealant as specified in the manufacturer's installation manual. Each section joint outer wall (casing) shall have a closure band.
- K. The chimney shall be designed to compensate for thermal expansion.
- L. Accessories:
  - 1. Fittings: Tees, elbows, increasers, draft-hood connectors, metal caps with bird barriers, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar or compatible materials and designs.
  - 2. The entire exhaust system, including all accessories (connectors, hardware, anchor plate supports, guides, drains, and terminals), shall be stainless steel.
  - 3. Sealant: Manufacturer's standard high-temperature sealant.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

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

#### 3.2 APPLICATION

- A. Listed Building-Heating-Appliance Chimneys: Dual-fuel boiler vents exposed within space.

#### 3.3 INSTALLATION OF LISTED CHIMNEYS

- A. When installed according to the manufacturer's installation instructions, the exhaust system and its supporting system shall resist side loads at least 1.5 times greater than the weight per foot of the piping for both horizontal and vertical portions of the system.
- B. The exhaust system shall be installed according to the manufacturer's instructions and shall conform to all applicable state and local codes.
- C. Provide all modular straight sections, fittings, supports, guides, expansion joints, guy sections, guy tensioners, roof thimbles, roof flashings, storm collars and stack cap terminations as required to provide a complete system per the manufacturer's instructions.

- D. The entire exhaust system from the appliance outlet to the termination point, including all accessories, except as noted, shall be from one manufacturer.
- E. The vertical termination shall be no less than two feet above any portion of the building within ten feet of the stack penetration. Follow all pertinent national, state, and/or local codes where applicable.
- F. Comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- G. Seal between sections of vents according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- H. Lap joints in direction of flow.
- I. Erect stacks plumb to finished tolerance of no more than 1 inch (25 mm) out of plumb from top to bottom.
- J. Provide tee fitting at the base of vent stack with condensate drain fitting at bottom of tee. Run condensate drain piping through chimney wall into boiler room to nearest floor drain.

#### 3.4 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.
- B. Provide temporary closures at ends of chimneys and stacks that are not completed or connected to equipment.

END OF SECTION 235133

## SECTION 235216 - CONDENSING BOILERS

### PART 1 GENERAL

#### 1.1 REFERENCE STANDARDS

- A. ASME CSD-1 - Controls and Safety Devices for Automatically Fired Boilers; 2021.

#### 1.2 RELATED DOCUMENTS

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

#### 1.3 SUMMARY

- A. Section includes gas-fired, fire-tube condensing boilers, trim, and accessories for generating hot water.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
  - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.
- B. Field quality-control reports.
- C. Sample Warranty: For special warranty.
- D. Product Certificates:
  - 1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.
  - 2. CSA B51 pressure vessel Canadian Registration Number (CRN).

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.

## 1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Fire-Tube Condensing Boilers:
    - a. Heat Exchanger, Pressure Vessel and Condensation Collection Basin shall carry a 10 year limited warranty against defects in materials or workmanship.
    - b. Heat exchangers/pressure vessel are warranted against thermal shock for the lifetime of the boiler.
    - c. The burner shall carry a five (5) year limited warranty against defective material or workmanship from the date of shipment.
    - d. All other components shall carry a one year limited warranty from date of boiler start up or 18 months from shipment if start up cannot be proven.

## 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. ASME Compliance: Fabricate and label boilers to comply with 2010 ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IES 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.
- E. UL Compliance: Test boilers for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- F. CSA Compliance: Test boilers for compliance with CSA B51.
- G. ASME CSD-1 Compliance: Boilers shall comply with Controls and Safety Devices for Automatically Fired Boilers

- H. NY Department of Labor, 12 NYCRR, Industrial Code Rule 4 Compliance: Compliance with requirements for low pressure boilers (12 NYCRR, Chapter 1, Subchapter A, Part 4 Low Pressure Boilers).
- I. Only low pressure boilers (as defined by 12 NYCRR Rule 4) shall be installed in school buildings (E Occupancy).

## 2.2 FORCED-DRAFT, FIRE-TUBE CONDENSING BOILERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Lochinvar (Basis of Design)
  - 2. Fulton.
  - 3. Bryan Boilers.
  - 4. AERCO.
- 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 NEMA designation, temperature rating, service factor, and efficiency requirements for motors 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.

## 2.3 TRIM

- A. Include devices sized to comply with ASME B31.9.
- 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: Nonoverloading, 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. Boiler operating controls shall include the following devices and features:
  - 1. Control transformer.
  - 2. Set-Point Adjust: Set points shall be adjustable.
  - 3. Operating Pressure Control: Factory wired and mounted to cycle burner.
  - 4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.
  - 5. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
    - a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
  - 6. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 0 deg F outside-air temperature, set supply-water temperature at 180 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 140 deg F.
    - a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
  - 7. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain a constant steam pressure. Maintain pressure set point plus or minus 10 percent.
    - a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
- B. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.

1. High Cutoff: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature.
2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.

## 2.5 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.
- B. 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. Install factory wiring outside of an enclosure in a metal raceway.
  4. Field power interface shall be to nonfused disconnect switch.
  5. Provide branch power circuit to each motor and to controls with a disconnect switch.
  6. Provide each motor with overcurrent protection.

## 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.

## 2.7 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 2010 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. 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 performance of the Work.
  - 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. Install gas-fired boilers according to NFPA 54.
- B. Assemble and install boiler trim.
- C. Install electrical devices furnished with boiler but not specified to be factory mounted.
- D. Install control wiring to field-mounted electrical devices.
- E. Install boilers with working clearances in accordance with the 2020 Mechanical Code of New York State Section 1004.3. Clearances shall be maintained around boilers so as to permit inspection, servicing, repair, replacement and visibility of all gauges. Where boilers are installed or replaced, clearance shall be provided to allow access for inspection, maintenance and repair.
  - 1. Passageways around all sides of boilers shall have an unobstructed width of not less than 18 inches, unless other approved.
  - 2. Clearances from the tops of boilers to the ceiling or other overhead obstruction shall be a minimum of 2 feet for all boilers without manholes on top of the boiler except where a greater clearance is required in Table 1004.3.1. of the 2020 MCNYS.

### 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 tapplings with shutoff valve and union or flange at each connection.
- G. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tapplings with shutoff valve and union or flange at each connection.
- H. Install piping from safety relief valves to nearest floor drain.
- I. Install piping from safety valves to drip-pan elbow and to nearest floor drain.
- J. Boiler Venting:
  - 1. Install flue venting kit and combustion-air intake.
  - 2. Connect full size to boiler connections.
- K. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- L. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following tests and inspections:
  - 1. 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.

- D. Boiler will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
- G. Performance Tests:
  - 1. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
  - 2. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
  - 3. Perform field performance tests to determine capacity and efficiency of boilers.
    - a. Test for full capacity.
    - b. Test for boiler efficiency at 20, 40, 60, 80 and 100 percent of full capacity. Determine efficiency at each test point.
  - 4. Repeat tests until results comply with requirements indicated.
  - 5. Provide analysis equipment required to determine performance.
  - 6. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are inadequate.
  - 7. Notify Architect 24 hours minimum in advance of test dates.
  - 8. Document test results in a report and submit to Architect.

### 3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain boilers. Refer to Section 017900 "Demonstration and Training."

END OF SECTION

## SECTION 236423 - AIR-COOLED, SCROLL WATER CHILLERS

### 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 packaged, air-cooled, electric-motor-driven, scroll water chillers.

#### 1.3 DEFINITIONS

- A. BAS: Building automation system.
- B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
- C. DDC: Direct digital control.
- D. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in Btu/h to the total power input given in watts at any given set of rating conditions.
- E. GFI: Ground fault interrupt.
- F. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.
- G. I/O: Input/output.
- H. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.
- I. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.
- J. SCCR: Short-circuit current rating.
- K. TEAO: Totally enclosed air over.
- L. TENV: Totally enclosed nonventilating.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include refrigerant, rated capacities, operating characteristics, and furnished specialties and accessories.
  - 2. Performance at AHRI standard conditions and at conditions indicated.
  - 3. Performance at AHRI standard unloading conditions.
  - 4. Minimum evaporator flow rate.
  - 5. Refrigerant capacity of water chiller.
  - 6. Oil capacity of water chiller.
  - 7. Fluid capacity of evaporator.
  - 8. Characteristics of safety relief valves.
  - 9. Force and moment capacity of each piping connection.
- B. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:
  - 1. Assembled unit dimensions.
  - 2. Weight and load distribution.
  - 3. Required clearances for maintenance and operation.
  - 4. Size and location of piping and wiring connections.
  - 5. Diagrams for power, signal, and control wiring.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Installation instructions.
- B. Source quality-control reports.
- C. Startup service reports.
- D. Sample Warranty: For special warranty.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.
- B. Spare Parts List: Recommended spare parts list with quantity for each.
- C. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

#### 1.7 QUALITY ASSURANCE

- A. AHRI Certification: Certify chiller according to AHRI 590 certification program.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

## 1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified warranty period.
  - 1. Extended warranties include, but are not limited to, the following:
    - a. Complete chiller including refrigerant and oil charge.
    - b. Complete compressor and drive assembly including refrigerant and oil charge.
    - c. Refrigerant and oil charge.
      - 1) Loss of refrigerant charge for any reason due to manufacturer's product defect and product installation.
    - d. Parts and labor.
  - 2. Warranty Period: Five years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.
- B. Performance Tolerance: Comply with the following in lieu of AHRI 550/590:
  - 1. Allowable Capacity Tolerance: Zero percent.
  - 2. Allowable Full-Load Energy Efficiency Tolerance: Zero percent.
  - 3. Allowable Part-Load Energy Efficiency Tolerance: Zero percent.
- C. AHRI Rating: Rate water chiller performance according to requirements in AHRI 550/590.
- D. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
- G. Comply with NFPA 70.

- H. Comply with requirements of UL 1995, "Heating and Cooling Equipment," and include label by a qualified testing agency showing compliance.
- I. Operation Following Loss of Normal Power:
  - 1. Equipment, associated factory- and field-installed controls, and associated electrical equipment and power supply connected to backup power system shall automatically return equipment and associated controls to the operating state occurring immediately before loss of normal power without need for manual intervention by an operator when power is restored either through a backup power source, or through normal power if restored before backup power is brought on-line.
  - 2. See drawings for equipment served by backup power systems.
  - 3. Provide means and methods required to satisfy requirement even if not explicitly indicated.
- J. Outdoor Installations:
  - 1. Chiller shall be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a 25-year period with minimal degradation due to exposure to outdoor ambient conditions.
  - 2. Chillers equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures encountered by the installation. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past 30-year period.

## 2.2 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with specifications, provide a product by one of the following:
  - 1. Daikin
  - 2. Dunham Bush
  - 3. Smardt
  - 4. Trane

## 2.3 MANUFACTURED UNITS

- A. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser with fans, electrical power, controls, and indicated accessories.
- B. Fabricate water chiller mounting base with reinforcement strong enough to resist water chiller movement during a seismic event when water chiller is anchored to field support structure.

- C. Sound-reduction package shall have the following:
  - 1. Acoustic enclosure around compressors.
  - 2. Reduced-speed fans with acoustic treatment.
  - 3. Designed to reduce sound level without affecting performance.
- D. Security Package: Security grilles with fasteners for additional protection of compressors, evaporator, and condenser coils. Grilles shall be coated for corrosion resistance and shall be removable for service access.

## 2.4 CABINET

- A. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
- B. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
- C. Casing: Galvanized steel.
- D. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500 hour salt-spray test according to ASTM B 117.

## 2.5 COMPRESSOR-DRIVE ASSEMBLIES

- A. Compressors:
  - 1. Description: Positive-displacement direct drive with hermetically sealed casing.
  - 2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
    - a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.
  - 3. Operating Speed: Nominal 3600 rpm for 60-Hz applications.
  - 4. Capacity Control: On-off compressor cycling, plus hot-gas bypass.
    - a. Digital compressor unloading is an acceptable alternative to achieve capacity control.
  - 5. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug or removable magnet in sump, and initial oil charge.
    - a. Manufacturer's other standard methods of providing positive lubrication are acceptable in lieu of an automatic pump.
  - 6. Vibration Isolation: Mount individual compressors on vibration isolators.
    - a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.
- B. Compressor Motors:

1. Hermetically sealed and cooled by refrigerant suction gas.
  2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.
- C. Compressor Motor Controllers:
1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

## 2.6 REFRIGERATION

- A. Refrigerant: R-410A. Classified as Safety Group A1 according to ASHRAE 34.
- B. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
- C. Refrigerant Circuit: Each circuit shall include an electronic or a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
- D. Refrigerant Isolation: Factory install positive shutoff isolation valves in the compressor discharge line and the refrigerant liquid-line to allow the isolation and storage of the refrigerant charge in the chiller condenser.
1. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in each circuit in lieu of each compressor.
- E. Pressure Relief Device:
1. Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
  2. Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.
  3. ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger.

## 2.7 EVAPORATOR

- A. Brazed-plate or shell-and-tube design, as indicated.
- B. Shell and Tube:
1. Description: Direct-expansion, shell-and-tube design with fluid flowing through the shell and refrigerant flowing through the tubes within the shell.
  2. Code Compliance: Tested and stamped according to ASME Boiler and Pressure Vessel Code.
  3. Shell Material: Carbon steel.
  4. Shell Heads: Removable carbon-steel heads with multipass baffles designed to ensure positive oil return and located at each end of the tube bundle.



5. Shell Nozzles: Fluid nozzles located along the side of the shell and terminated with mechanical-coupling end connections for connection to field piping.
  6. Tube Construction: Individually replaceable copper tubes with enhanced fin design, expanded into tube sheets.
- C. Brazed Plate:
1. Direct-expansion, single-pass, brazed-plate design.
  2. Type 316 stainless-steel construction.
  3. Code Compliance: Tested according to ASME Boiler and Pressure Vessel Code.
  4. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.
  5. Inlet Strainer: Factory-furnished, 20 or 40 -mesh strainer for field installation in supply piping to evaporator. Manufacturer has option to factory install strainer.
- D. Flow Switch: Factory-furnished and -installed, thermal-type flow switch wired to chiller operating controls.
- E. Heater: Factory-installed and -wired electric heater with integral controls designed to protect the evaporator to minus 20 deg F.
- F. Remote-Mounting Kit: Designed for remote field mounting where indicated. Provide kit for field installation.

## 2.8 AIR-COOLED CONDENSER

- A. Coil(s) with integral subcooling on each circuit.
- B. Copper Tube with Plate Fin Coils:
1. Construct coils of copper tubes mechanically bonded to aluminum fins.
- C. Aluminum Microchannel Coils:
1. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
  2. Single- or multiple-pass arrangement.
  3. Construct fins, tubes, and header manifolds of aluminum alloy treated with a corrosion-resistant coating.
- D. Corrosion-Resistant Coating: Coat coils with an epoxy or a phenolic corrosion-resistant coating after fabrication.
- E. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
- F. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.

- G. Fan Motors: TENV or TEAO enclosure, with sealed and permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.
  - 1. Overcurrent- and thermal-overload protection not integral to motor is acceptable if provided with chiller electrical power package.
- H. Fan Guards: Removable steel safety guards with corrosion-resistant coating.

## 2.9 INSULATION

- A. Closed-cell, flexible, elastomeric thermal insulation complying with ASTM C 534/C 534M, Type I for tubular materials and Type II for sheet materials.
  - 1. Thickness: 1-1/2 inches
- B. Adhesive: As recommended by insulation manufacturer.
- C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
  - 1. Apply adhesive to 100 percent of insulation contact surface.
  - 2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
  - 3. Seal seams and joints to provide a vapor barrier.
  - 4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
  - 5. Manufacturer has option to factory or field insulate chiller components to reduce potential for damage during installation.
  - 6. Field-Applied Insulation:
    - a. Components that are not factory insulated shall be field insulated to comply with requirements indicated.
    - b. Manufacturer shall be responsible for chiller insulation whether factory or field installed to ensure that manufacturer is the single point of responsibility for chillers.
    - c. Manufacturer's factory-authorized service representative shall instruct and supervise installation of field-applied insulation.
    - d. After field-applied insulation is complete, paint insulation to match factory-applied finish.

## 2.10 ELECTRICAL

- A. Factory installed and wired, and functionally tested at factory before shipment.

- B. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
- C. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.
- D. Wiring shall be numbered and color-coded to match wiring diagram.
- E. Factory wiring shall be located outside of an enclosure in a metal raceway. Terminal connections shall be made with not more than a 24-inch length of liquidtight conduit.
- F. Field power interface shall be to NEMA KS 1, heavy-duty, nonfused disconnect switch. Minimum SCCR according to UL 508 shall be as required by electrical power distribution system, but not less than 65,000A.
- G. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:
  - 1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
  - 2. NEMA KS 1, heavy-duty, nonfusible switch.
  - 3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- H. Each motor shall have overcurrent protection.
- I. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
- J. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
- K. Power Factor Correction: Capacitors to correct power factor to 0.90 at full load.
- L. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- M. Control Relays: Auxiliary and adjustable time-delay relays, or an integral to water chiller microprocessor.
- N. Service Receptacle:
  - 1. Unit-mounted, 120-V GFI duplex receptacle.
  - 2. Power receptacle from chiller internal electrical power wiring.
- O. Indicate the following for water chiller electrical power supply:
  - 1. Current, phase to phase, for all three phases.
  - 2. Voltage, phase to phase and phase to neutral for all three phases.

3. Three-phase real power (kilowatts).
4. Three-phase reactive power (kilovolt amperes reactive).
5. Power factor.
6. Running log of total power versus time (kilowatt hours).
7. Fault log, with time and date of each.

## 2.11 CONTROLS

- A. Factory installed and wired, and functionally tested at factory before shipment.
- B. Standalone, microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
- C. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
- D. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, digital display. Display the following:
  1. Date and time.
  2. Operating or alarm status.
  3. Operating hours.
  4. Outside-air temperature if required for chilled-water reset.
  5. Temperature and pressure of operating set points.
  6. Chilled-water entering and leaving temperatures.
  7. Refrigerant pressures in evaporator and condenser.
  8. Saturation temperature in evaporator and condenser.
  9. No cooling load condition.
  10. Elapsed time meter (compressor run status).
  11. Pump status.
  12. Antirecycling timer status.
  13. Percent of maximum motor amperage.
  14. Current-limit set point.
  15. Number of compressor starts.
  16. Alarm history with retention of operational data before unit shutdown.
  17. Superheat.
- E. Control Functions:
  1. Manual or automatic startup and shutdown time schedule.
  2. Capacity control based on evaporator leaving-fluid temperature.
  3. Capacity control compensated by rate of change of evaporator entering-fluid temperature.
  4. Chilled-water entering and leaving temperatures, control set points, and motor load limit. Chilled-water leaving temperature shall be reset based on outside-air temperature.

5. Current limit and demand limit.
  6. Condenser-water temperature.
  7. External water chiller emergency stop.
  8. Antirecycling timer.
  9. Automatic lead-lag switching.
- F. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
1. Low evaporator pressure or high condenser pressure.
  2. Low chilled-water temperature.
  3. Refrigerant high pressure.
  4. High or low oil pressure.
  5. High oil temperature.
  6. Loss of chilled-water flow.
  7. Loss of condenser-water flow.
  8. Control device failure.
- G. BAS System Interface: Factory-install hardware and software to enable system to monitor, control, and display chiller status and alarms.
1. Hardwired I/O Points:
    - a. Monitoring: On/off status, common trouble alarm, electrical power demand (kilowatts), electrical power consumption (kilowatt hours)
    - b. Control: On/off operation, chilled-water discharge temperature set-point adjustment, electrical power demand limit
  2. Communication Interface: ASHRAE 135 (BACnet) communication interface shall enable control system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through DDC system for HVAC.
- H. Factory-installed wiring outside of enclosures shall be in NFPA 70-complaint raceway. Make terminal connections with liquidtight conduit.

## 2.12 ACCESSORIES

- A. Factory-furnished spring isolators for field installation.
1. Spring Deflection: 2 inches

## 2.13 SOURCE QUALITY CONTROL

- A. Perform functional test of water chillers before shipping.
- B. Factory performance test water chillers, before shipping, according to AHRI 550/590.
1. Test the following conditions:
    - a. Design conditions indicated.

- b. AHRI 550/590 part-load points.
- C. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
- D. For water chillers located outdoors, rate sound power level according to AHRI 370 procedure.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
  - 1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 WATER CHILLER INSTALLATION

- A. Coordinate sizes and locations of bases with actual equipment provided. Cast anchor-bolt inserts into concrete bases.
- B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures with actual equipment provided.
- C. Install water chillers on support structure indicated.
- D. Equipment Mounting:
  - 1. Install water chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
  - 2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- E. Maintain manufacturer's recommended clearances for service and maintenance.
- F. Maintain clearances required by governing code.
- G. Chiller manufacturer's factory-trained service personnel shall charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.
- H. Install separate devices furnished by manufacturer and not factory installed.

1. Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

### 3.3 PIPING CONNECTIONS

- A. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Section 232300 "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- C. Where installing piping adjacent to chillers, allow space for service and maintenance.
- D. Evaporator Fluid Connections:
  1. Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage.
  2. Connect to evaporator outlet with shutoff valve, balancing valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, and drain connection with valve.
  3. Make connections to water chiller with a flange or mechanical coupling.
- E. Connect each drain connection with a drain valve, full size of drain connection. Connect drain pipe to drain valve with union and extend drain pipe to terminate over floor drain.
- F. Connect each chiller vent connection with an automatic vent, full size of vent connection.

### 3.4 ELECTRICAL POWER CONNECTIONS

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Provide nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch (13 mm) high. Locate nameplate where easily visible.

### 3.5 CONTROLS CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.

- B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.
- C. Connect control wiring between chiller control interface and DDC system for remote monitoring and control of chillers. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."
- D. Provide nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high.

### 3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
  - 1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
  - 2. Verify that pumps are installed and functional.
  - 3. Verify that thermometers and gages are installed.
  - 4. Operate water chiller for run-in period.
  - 5. Check bearing lubrication and oil levels.
  - 6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.
  - 7. Verify proper motor rotation.
  - 8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
  - 9. Verify and record performance of chilled-water flow and low-temperature interlocks.
  - 10. Verify and record performance of water chiller protection devices.
  - 11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.
- E. Prepare a written startup report that records results of tests and inspections.

### 3.7 DEMONSTRATION



- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers. Video record the training sessions and provide electronic copy to Owner.
  - 1. Instructor shall be factory trained and certified.
  - 2. Provide not less than eight hours of training.
  - 3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
  - 4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
  - 5. Obtain Owner sign-off that training is complete.
  - 6. Owner training shall be held at Project site.

END OF SECTION

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## SECTION 237232 - PACKAGED ENERGY RECOVERY VENTILATORS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Packaged energy recovery ventilators:
    - a. Fixed core type.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-to-air energy recovery equipment to include in maintenance manuals.
- B. Start-up and inspection reports prepared by factory authorized representative.

#### 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. Filters: One set(s) of each type of filter specified.
  - 2. Fan Belts: One set(s) of belts for each belt-driven fan in energy recovery units.

#### 1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. AHRI Compliance:
  - 1. Capacity ratings for air-to-air energy recovery equipment shall comply with AHRI 1060, "Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Equipment."
- C. NRCA Compliance: Roof curbs for roof-mounted equipment shall be constructed according to recommendations of NRCA.
- D. UL Compliance:

1. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators".

## 1.6 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

## 1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specified warranty period.
  1. Warranty Period for Packaged Energy Recovery Units: 5 years.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide units manufactured by Renewaire or comparable product by one of the following:
  1. Aldes
  2. Fantech

### 2.2 MANUFACTURED UNITS

- A. Air-to-Air Energy Recovery Ventilators shall be fully assembled at the factory and consist of a fixed-plate cross-flow heat exchanger with no moving parts, an insulated single wall painted 20-gauge steel cabinet, backdraft outside air damper, filter assemblies for both intake and exhaust air, enthalpy core, supply air blower assembly, backdraft exhaust air damper, exhaust air blower assembly and electrical control box with all specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection. Entire unit with the exception of field-installed components shall be assembled and test operated at the factory.

### 2.3 CABINET

- A. Materials: Formed single wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
- B. Outside casing: 20 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish. Painted components as supplied by the factory shall have polyester urethane paint on 20 gauge G90 galvanized steel.

- C. Access doors shall be hinged with airtight closed cell foam gaskets. Door pressure taps, with captive plugs, shall be provided for cross-core pressure measurement allowing for accurate airflow measurement.
- D. Unit shall have factory-installed duct flanges on all duct openings.
- E. Cabinet Insulation: Unit walls and doors shall be insulated with 1 inch, 4 pound density, foil/scrim faced, high density fiberglass board insulation, providing a cleanable surface and eliminating the possibility of exposing the fresh air to glass fibers, and with a minimum R-value of 4.3 (hr-ft<sup>2</sup>-°F/BTU).
- F. Enthalpy core: Energy recovery core shall be of the total enthalpy type, capable of transferring both sensible and latent energy between airstreams. Latent energy transfer shall be accomplished by direct water vapor transfer from one airstream to the other, without exposing transfer media in succeeding cycles directly to the exhaust air and then to the fresh air. No condensate drains shall be allowed. The energy recovery core shall be designed and constructed to permit cleaning and removal for servicing. The energy recovery core shall have a ten year warranty. Performance criteria are to be as specified in AHRI Standard 1060.
- G. Control center / connections: Energy Recovery Ventilator shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections to the [non-fused][fused] disconnect.
- H. Passive Frost Control: The ERV core shall perform without condensing or frosting under normal operating conditions (defined as outside temperatures above -10°F and inside relative humidity below 40%). Occasional more extreme conditions shall not affect the usual function, performance or durability of the core. No condensate drains will be allowed.
- I. Backdraft Isolation Damper(s): Exhaust Air backdraft damper and Outside Air backdraft damper of an AMCA Class I low leakage type shall be factory installed.

## 2.4 BLOWER SECTION

- A. Blower section construction, Supply Air and Exhaust Air: Blower assemblies consist of a 208-230V 1 Phase 60 HZ, ECM motor, and a direct driven backward-inclined blower.
- B. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.

## 2.5 MOTORS

- A. Blower motors shall be Premium Efficiency, EISA compliant for energy efficiency. The blower motors shall be totally enclosed (TEFC) and shall be supplied with factory installed motor starters.

## 2.6 UNIT CONTROLS

- A. Fan control: Dual contactors for independent blower control.
- B. Bypass economizer control: Differential enthalpy control, 2 position dampers with 100% airflow through the core or 100% airflow bypassing the core.
- C. Sensors: Dirty filter monitor for both airstreams.
- D. Timeclock: Digital Time Clock wall mount with up to 8 on/off cycles per day or 50 per week, 24VAC power, with battery backup protection of program settings against power failure to energize unit

## 2.7 FILTER SECTION

- A. ERV shall have 2" thick MERV 8 disposable pleated filters located in the outdoor air and exhaust airstreams. All filters shall be accessible from the exterior of the unit.

## 2.8 ELECTRIC DUCT HEATERS

- A. Duct heaters shall be open coil heaters.
  - 1. Voltage, size, wattage, control type and control voltage shall be as scheduled on the drawings.
  - 2. Manufacturer shall be capable of furnishing three-phase heaters. Refer to mechanical schedules.
  - 3. Heaters shall be UL listed for zero clearance and meet all applicable requirements of the NEC.
  - 4. Electric duct heaters shall be independently powered.
- B. Type: Heaters shall be of the slip-in mount type for duct mounting.
- C. Duct heaters shall be for indoor use only.
- D. Heating Elements: Open coil of resistance wire, 60 percent nickel, 20 percent chromium, and 20 percent iron supported and insulated by floating ceramic bushings. Heating element support structure shall consist of galvanized steel wire formed and constructed to support ceramic bushings through which the heating element passes.
- E. All heating elements shall be made of nickel/chromium resistance wire with ends terminated by means of staking and heliarc welding to machine screws.

- F. Coil Layout: Vertical (air flow horizontal). Heater shall be capable of being installed where airflow in ductwork is vertical through the heater.
- G. Casing Assembly: Slip-in type, galvanized-steel frame
- H. Coil terminals shall be stainless steel plated, terminal insulators and bracket bushings shall be of ceramic and securely positioned.
- I. Control Box: Control cabinet shall have a solid cover also of heavy gauge galvanized steel and held in place with hinges and interlocking disconnect switch.
- J. Orientation: Heaters shall be interchangeable for mounting in a horizontal or vertical duct.
- K. Built-in components shall include disconnecting break magnetic contactors, transformer with primary fusing, pressure-type airflow switch set at 0.05" + 0.02" WC all as required by UL, branch circuit fuses per NEC, interlocking disconnect switch and a single terminal block to accept the number, type and size of conductors as required.
- L. Over-Temperature Protection:
  - 1. Serviceable through electric duct heater without removing heater from duct or unit.
  - 2. Disk-type, automatic reset, thermal-cutout safety devices for primary over-temperature protection.
  - 3. Secondary over-temperature protection by built in disc type manually resettable thermal cutouts. These devices must function independently of one another and are not acceptable if series connected in the control circuit wiring.
  - 4. All duct heaters will require either a fan interlock circuit or an airflow switch. The airflow switch shall be diaphragm operated differential pressure switch to prevent duct heater from operating when there is no air flow.
- M. A disconnecting magnetic control circuit is required.
- N. Over-current protection by means of factory-installed fusing within the control cabinet shall be provided. Heating elements shall be subdivided and fused accordingly.
- O. All wiring, component sizing, component spacing and protective devices within the control cabinet shall be factory installed and comply with NEC and UL standards.
- P. Control Panel: Mounted on unit, with means of a safety disconnect and overcurrent protection. Include the following controls:
  - 1. Magnetic contactor.
  - 2. Silicon Controlled Rectifier (SCR) control with thermostat and sensor.
  - 3. Dust tight control box via compression type gasket installed on control box flanges to seal door opening. Control box seams are filled to prevent dust intrusion.

4. Time delay relay
  5. Pilot light to indicate the heater is energized
  6. 24V control voltage
- Q. A wiring diagram depicting layout and connections of electrical components within the control cabinet shall be affixed to the inside of the control cabinet cover.
- R. A rating plate label shall be affixed to the exterior of the control cabinet cover which states model number, serial number, volts, amps, phase, frequency, control volts, volt-amps and minimum airflow requirements.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Roof Curb: Furnish to roofing installer for installation.
- B. Install units with clearances for service and maintenance.
- C. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

#### 3.3 CONNECTIONS

- A. Install devices furnished with units but not factory mounted.

#### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
  1. Prepare inspection and start-up reports.



3.5 DEMONSTRATION

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

END OF SECTION 237232

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## SECTION 237313 - INDOOR AIR HANDLING UNITS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Constant-air-volume, single-zone air-handling units.

#### 1.2 ACTION SUBMITTALS

- A. AHU manufacturer shall provide the following information with each shop drawing/product data submission:
  - 1. Dimensioned arrangement drawings for each AHU including a plan and elevation view of the assembled unit with overall dimensions, lift points, unit shipping split locations and dimensions, installation and operating weights, and installation, operation and service clearances.
  - 2. All electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations.
  - 3. Each component of the unit shall be identified and mechanical specifications shall be provided for unit and accessories describing construction, components, and options.
  - 4. All performance data, including capacities and airside and waterside pressure drops, for components.
  - 5. Fan curves shall be provided for fans with the design operating points indicated. Data shall be corrected to actual operating conditions, temperatures, and altitudes.
  - 6. A filter schedule must be provided for each air handling unit supplied by the air handling unit manufacturer. Schedule shall detail unit tag, unit size, corresponding filter section location within the AHU, filter arrangement (e.g. angled/flat), filter depth, filter type (e.g. pleated media), MERV rating, and filter quantity and size.
  - 7. A schedule detailing necessary trap height shall be provided for each air handling unit. Schedule shall detail unit tag, unit size, appropriate trap schematic with recommended trap dimensions, and unit supplied base rail height. Contractor shall be responsible for additional trap height required for trapping and insulation beyond the unit supplied base rail height by adequate housekeeping pad.
  - 8. An electrical MCA – MOP schedule shall be provided for each electrical circuit to which field-power must be supplied. Schedule to detail unit tag, circuit description, voltage/phase/hertz, Minimum Circuit Ampacity (MCA), and calculated Maximum Overcurrent Protection (MOP).

9. Sound data shall be provided using ARI 260 test methods. Unit discharge, inlet, and radiated sound power levels in dB shall be provided for 63, 125, 250, 500, 1000, 2000, 4000, and 8000 Hz.

- B. The AHU manufacturer shall list any exceptions to the specification.

### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.
- B. Include an electronic copy of the IOM.

### 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. Filters: One set(s) for each air-handling unit.
  2. Fan Belts: One set(s) for each air-handling unit fan.

### 1.5 QUALITY ASSURANCE

- A. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- B. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with current ARI Standard 410.
- C. Certify air handling units in accordance with ARI Standard 430.
- D. Airflow monitoring station: Certify airflow measurement station performance in accordance with AMCA 611.
- E. ISO 9001 Certification.
- F. Units shall be manufactured to conform to UL 1995 and shall be listed by either UL/CUL or ETL. Units shall be provided with listing agency label affixed to the unit. In the event the unit is not UL/CUL or ETL approved, the contractor shall, at his/her expense, provide for a field inspection by a UL/CUL or ETL representative to verify conformance. If necessary, contractor shall perform modifications to the unit to comply with UL/CUL or ETL as directed by the representative, at no additional expense to the owner.

### 1.6 COORDINATION

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

- B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturer must clearly define any exceptions made to Plans and Specifications. Any deviations in layout or arrangement shall be submitted to consulting engineer prior to bid date. Acceptance of deviation(s) from specifications shall be in the form of written approval from the consulting engineer. Mechanical Contractor is responsible for expenses that occur due to exceptions made.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Daikin
  - 2. Carrier Air Conditioning.
  - 3. The Trane Co.

### 2.2 GENERAL

- A. Unit layout and configuration shall be as defined in project plans and schedules.
- B. Entire unit shall have an 8-inch full perimeter base rail.

### 2.3 UNIT CASING

- A. Unit manufacturer shall ship separate segments so unit can be broken down for ease of installation in tight spaces. The entire air handler shall be constructed of galvanized steel. Casing finished to meet ASTM B117 250-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.
- B. Casing performance – Casing air leakage shall not exceed leak class 6 (CL = 6) per ASHRAE 111 at specified casing pressure, where maximum casing leakage (cfm/100 ft<sup>2</sup> of casing surface area) = CL X P<sup>0.65</sup>.
- C. Air leakage shall be determined at a casing static pressure of 8 inches w.g. Specified air leakage shall be accomplished without the use of caulk. Total estimated air leakage shall be reported for each unit in CFM, as a percentage of supply air, and as an ASHRAE 111 Leakage Class.

- D. Under 55°F supply air temperature and design conditions on the exterior of the unit of 81°F dry bulb and 73°F wet bulb, condensation shall not form on the casing exterior. The AHU manufacturer shall provide tested casing thermal performance for the scheduled supply air temperature plotted on a psychrometric chart. The design condition on the exterior of the unit shall also be plotted on the chart. If tested casing thermal data is not available, AHU manufacturer shall provide, in writing to the Engineer and Owner, a guarantee against condensation forming on the unit exterior at the stated design conditions above. The guarantee shall note that the AHU manufacturer will cover all expenses associated with modifying units in the field should external condensate form on them. In lieu of AHU manufacturer providing a written guarantee, the installing contractor must provide additional external insulation on AHU to prevent condensation.
- E. Unit casing (wall/floor/roof panels and doors) shall be able to withstand up to 1.5 times design static pressure, or 8" w.g., whichever is less, and shall not exceed 0.0042" per inch of panel span (L/240).
- F. Floor panels shall be double-wall construction and designed to support a 250-lb load during maintenance activities and shall deflect no more than 0.0042" per inch of panel span.
- G. Unit casing panels shall be 2" double-wall construction, with solid galvanized exterior and solid galvanized interior, to facilitate cleaning of unit interior.
- H. Unit casing panels (roof, walls, floor) and doors shall be provided with a minimum thermal resistance (R-value) of 13 Hr\*Ft<sup>2</sup>\*°F/BTU.
- I. Unit casing panels (roof, walls, floor) and external structural frame members shall be completely insulated filling the entire panel cavity in all directions so that no voids exist. Panel insulation shall comply with NFPA 90A.
- J. Casing panel inner liners must not extend to the exterior of the unit or contact the exterior frame. A mid-span, no-through-metal, internal thermal break shall be provided for all unit casing panels.
- K. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.
- L. Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.

## 2.4 ACCESS DOORS

- A. Access doors shall be 2" double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels.

- B. All doors downstream of cooling coils shall be provided with a thermal break construction of door panel and door frame.
- C. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.
- D. Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.
- E. Handle hardware shall be designed to prevent unintended closure.
- F. Access doors shall be hinged and removable without the use of specialized tools to allow.
- G. Hinges shall be interchangeable with the door handle hardware to allow for alternating door swing in the field to minimize access interference due to unforeseen job site obstructions.
- H. Door handle hardware shall be adjustable and visually indicate locking position of door latch external to the section.
- I. All doors shall be a minimum 60" high when sufficient height is available, or the maximum height allowed by the unit height.
- J. Door handles shall be provided for each latching point of the door necessary to maintain the specified air leakage integrity of the unit.

## 2.5 GENERAL

- A. General Description: Factory assembled, double wall construction, consisting of individual sectionalized components as listed and described.
- B. The configurations and sections required for each air handling unit is shown on the drawings.

## 2.6 UNIT CASING

- A. Materials: Formed and reinforced galvanized steel panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed. All sections shall be the same height and width.
  - 1. Exterior Wall: Minimum 18 gauge.
  - 2. Interior Wall: Minimum 22 gauge.
  - 3. Medium- and high-pressure units shall be constructed with additional bracing and supports. Units rated at 5.5 inches w.g. and higher shall be connected to accessories sections with double-thickness neoprene-coated flexible connection.

- B. Insulation: Double wall construction with 2" thick, 1 1/2 lb/cu. ft. density insulation having a thermal resistance of 7.6 degree F-sq. ft.-hr/Btu.
- C. Access Panels and Doors: Provide hinged and gasketed access doors to each air handling component specified. Access doors shall be of the same construction as the unit casing and shall be provided with a minimum of 2 safety latches.

## 2.7 FANS SECTION

- A. Provide fans of type and class as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. All fans shall be statically and dynamically tested by the manufacturer for vibration and alignment as an assembly at the operating RPM to meet design specifications. Fans controlled by variable frequency drives shall be statically and dynamically tested for vibration and alignment at speeds between 25% and 100% of design RPM. If fans are not factory-tested for vibration and alignment, the contractor shall be responsible for cost and labor associated with field balancing and certified vibration performance. Fan wheels shall be keyed to fan shafts to prevent slipping.
- B. Belt-driven fans shall be provided with grease lubricated, self-aligning, anti-friction bearings selected for L-50 200,000-hour average life per ANSI/AFBMA Standard 9. Lubrication lines for both bearings shall be extended to the drive side of the AHU and rigidly attached to support bracket with zerk fittings. Lubrication lines shall be a clear, high-pressure, polymer to aid in visual inspection. If extended lubrication lines are not provided, manufacturer shall provide permanently lubricated bearing with engineering calculations for proof of bearing life.
- C. Fans shall be mounted on isolation bases. Internally-mounted motor shall be on the same isolation base. Fan and motor shall be internally isolated with 2-inch isolators. A flexible connection (e.g. canvas duct) shall be installed between fan and unit casing to ensure complete isolation. Flexible connection shall comply with NFPA 90A and UL 181 requirements. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External isolation shall be furnished by the installing contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.
- D. Fan sections shall have a minimum of one access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components. Construct door(s) per Section 2.04.
- E. Belts shall be enclosed as required by OSHA standard 29 CFR 1910 to protect worker from accidental contact with the belts and sheaves.



F. Fan Airflow Measurement Systems

1. Fan airflow measurement systems shall be provided on all fans to measure fan airflow directly or to measure differential pressure that can be used to calculate fan airflow. The accuracy of the devices shall be no worse than +/-5% when operating within stable fan operating conditions. Devices shall not affect the submitted fan performance and acoustical levels. Devices that obstruct the fan inlet or outlet shall not be acceptable. Devices shall be connected to transducers with selectable 4-20 mA or 2-10 VDC output. Signal shall be proportional to air velocity.

2.8 MOTORS AND DRIVES

- A. All motors and drives shall be factory-installed and run tested. All motors shall be installed on a slide base to permit adjustment of belt tension. Slide base shall be designed to accept all motor sizes offered by the air-handler manufacturer for that fan size to allow a motor change in the future, should airflow requirements change. Fan sections without factory-installed motors shall have motors field installed by the contractor. The contractor shall be responsible for all costs associated with installation of motor and drive, alignment of sheaves and belts, run testing of the motor, and balancing of the assembly.
- B. Motors shall meet or exceed all NEMA Standards Publication MG 1 – 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.
- C. Fan Motors shall be heavy duty, NEMA Premium efficient ODP, operable at 460/60/3, exceeding the EPAct efficiency requirements.
- D. Motors shall be 1800 rpm, except where noted, and shall NEMA Design B, with Class B insulation to operate continuously at 104°F (40°C) ambient without tripping of overloads.
- E. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.
- F. V-Belt Drive shall be fixed pitch rated at 1.5 times the motor nameplate. Drives 20 hp and larger or any drives on units equipped with VFDs shall be fixed pitch.
- G. Manufacturer shall provide for each fan a nameplate with the following information to assist air balance contractor in startup and service personnel in maintenance:
  1. Fan and motor sheave part number
  2. Fan and motor bushing part number
  3. Number of belts and belt part numbers
  4. Fan design RPM and motor HP
  5. Belt tension and deflection

6. Center distance between shafts

- H. All fans with motors 15 hp and larger shall be equipped with multiple belt drives.
- I. Fan airflow measurement systems shall be provided on Supply and Return fans to measure fan airflow directly or to measure differential pressure that can be used to calculate airflow. The accuracy of the devices shall be no worse than +/- 5 percent when operating within stable fan operating conditions. Devices shall not affect the submitted fan performance and acoustical levels. Devices that obstruct the fan inlet or outlet shall not be acceptable. Devices shall be connected to transducers with selectable 4-20 mA or 2-10 VDC output. Signal shall be proportional to air velocity.

2.9 COILS

- A. Coils section side panels shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.
- B. Coils shall be manufactured with plate fins to maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.
- C. Construct coil casings of galvanized steel. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.
- D. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be degreased and steam cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated.
- E. Hydronic Coils
  - 1. Supply and return header connections shall be clearly labeled on unit exterior such that direction of coil water-flow is counter to direction of unit air-flow.
  - 2. Coils shall be proof-tested to 300 psig and leak-tested to 200 psig air pressure under water.
  - 3. Headers shall be constructed of round copper pipe or cast iron.
  - 4. Tubes shall be 1/2 inch O.D., minimum 0.016 inch thick copper. Fins shall be aluminum.
  - 5. Hydronic coils shall be supplied with factory installed drain and vent piping to the unit exterior.

2.10 DAMPERS SECTIONS

- A. Mixing Boxes: Parallel-blade dampers in a reinforced, galvanized steel cabinet. Damper blades shall be galvanized steel mechanically fastened to steel operating rod. Connect operating rods for each set of dampers together with a common linkage and interconnect linkages so dampers operate simultaneously and in the opposite direction (one opens when the other closes).
- B. Combination Filter/Mixing Box: Parallel-blade dampers in a reinforced, galvanized steel cabinet. Damper blades shall be galvanized steel mechanically fastened to steel operating rod. Connect operating rods for each set of dampers together with a common linkage and interconnect linkages so dampers operate simultaneously and in the opposite direction (one opens when the other closes). Cabinet shall have support members to hold 2-inch-thick, pleated, flat permanent or throwaway filters. Mixing boxes shall have hinged access panels or doors to allow removal of filters for both sides of unit.
- C. Outdoor Air Damper/Airflow Monitoring Station: Factory mounted combination outdoor air damper and airflow monitoring station located in the outdoor air opening of the combination filter mixing box or mixing box. Damper blades shall be galvanized steel, in a galvanized steel frame, mechanically fastened to steel operating rod. The airflow sensor shall measure from 15 to 100 percent of total outside air with an accuracy of plus or minus 5 percent and shall adjust for temperature variations. The airflow sensor shall have a 2-10 Vdc output signal proportional to velocity.
- D. Economizer: Factory fabricated section with return air inlet and exhaust air damper outlet. Damper shall be opposed blade galvanized steel, in galvanized frame, with steel operating rod and continuous vinyl seals between damper blades.

## 2.11 DAMPERS

- A. All dampers shall be internally mounted. Dampers shall be premium ultra-low leak. Blade arrangement parallel shall be provided as indicated on the schedule and drawings. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 4 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage and shall be AMCA licensed for Class 1A. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. Manufacturer shall submit brand and model of damper(s) being furnished, if not Ruskin CD60.
- B. Airflow measuring stations shall be provided and located in the outside paths to measure airflow. Airflow measuring stations shall be tested per AMCA Standard 611 and licensed to bear the AMCA Ratings Seal for airflow measurement performance. Integral control damper blades shall be provided as galvanized steel and housed in a galvanized steel frame. Leakage rate shall not exceed 4 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage.

- C. The airflow measurement station shall measure up to 100 percent of the total outside air. The airflow measurement station shall be capable of measuring down to 300 fpm. The airflow measuring device shall adjust for temperature variations. Output shall be provided from the station as a 2-10 VDC signal. Signal shall be proportional to air velocity. The accuracy of the measuring station shall be no greater than +/- 5 percent. Airflow measuring stations shall be mounted on the AHU interior.

## 2.12 FILTERS

- A. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter section shall have filter guides and access door(s) extending the full height of the casing to facilitate filter removal. Provide fixed filter blockoffs as required to prevent air bypass around filters. Blockoffs shall not need to be removed during filter replacement.
- B. Filter type, MERV rating, and arrangement shall be provided as defined in project plans and schedules.
- C. Manufacturer shall provide three sets of filters.
  - 1. One set of filters for construction phase.
  - 2. One set of specified filters installed prior to testing and balancing.
  - 3. One set of spare filters.
- D. Filter Gage:
  - 1. 3-1/2-inch diameter, diaphragm-actuated dial in metal case.
  - 2. Vent valves.
  - 3. Black figures on white background.
  - 4. Front recalibration adjustment.
  - 5. 3 percent of full-scale accuracy.
  - 6. Range: 0- to 0.5-inch wg.
  - 7. Accessories: Static-pressure tips with integral compression fittings, 1/4-inch aluminum tubing.

## 2.13 DISCHARGE PLENUM SECTION

- A. Factory fabricated plenum with openings matching sizes and locations indicated on the drawings.

## 2.14 ACCESS SECTIONS

- A. Access sections shall be provided where indicated in the schedule and plans to allow additional access for inspection, cleaning, and maintenance of unit components. The unit shall be installed for proper access. Procedure for proper access, inspection and cleaning of the unit shall be provided in the AHU manufacturer's maintenance manual.

## PART 3 EXECUTION

### 3.1 SHIPPING

- A. Paper copies of the IOM shall be shipped with each AHU.
- B. The AHU manufacturer shall identify all shipments with the order number. Enough information shall be provided with each shipment to enable the Mechanical Contractor to confirm the receipt of units when they are received. For parts too small to mark individually, the AHU manufacturer shall place them in containers.
- C. To protect equipment during shipment and delivery, all indoor units shall be completely stretch or shrink wrapped. Wrap shall be a minimum of 7 mil plastic. Pipe ends and pipe connection holes in the casing shall be capped or plugged prior to shipment.
- D. After loading the equipment for shipment, the AHU manufacturer shall contact the shipping contact on the order and provide the name of the carrier, description of equipment, order number, shipping point, and date of shipment.

### 3.2 ON-SITE STORAGE

- A. If equipment is to be stored for a period of time prior to installation, the Mechanical Contractor shall remove all stretch or shrink wrap from units upon receipt to prevent unit corrosion and shall either place the units in a controlled indoor environment or shall cover the units with canvas tarps and place them in a well-drained area. Covering units with plastic tarps shall not be acceptable.

### 3.3 FIELD EXAMINATION

- A. The Mechanical Contractor shall verify that the mechanical room and/or roof are ready to receive work and the opening dimensions are as indicated on the shop drawings and contract documents.
- B. The Mechanical Contractor shall verify that the proper power supply is available prior to starting of the fans.

### 3.4 INSTALLATION

- A. Equipment Mounting: Install air-handling units on concrete bases using elastomeric pads. Secure units to anchor bolts installed in concrete bases.
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction, with new, clean filters.
- D. Coordinate installation requirements to ensure that a complete installation for each unit is being provided. Coordination efforts shall include such items as unloading and hoisting requirements, field wiring requirements, field piping requirements, field ductwork requirements, requirements for assembly of field-bolted or welded joints, and all other installation and assembly requirements.
- E. The AHU manufacturer shall provide all screws and gaskets for joining of sections in the field.
- F. The Mechanical Contractor shall verify that the following items have been completed prior to scheduling the AHU manufacturer's final inspection and start up:
  - 1. All spring-isolated components have had their shipping restraints removed and the components have been leveled.
  - 2. On all field-joined units, that all interconnections have been completed, i.e., electrical and control wiring, piping, casing joints, bolting, welding, etc.
  - 3. All water and steam piping connections have been completed and hydrostatically tested and all water flow rates have been set in accordance with the capacities scheduled on the Drawings.
  - 4. All ductwork connections have been completed and all ductwork has been pressure tested for its intended service.
  - 5. All power wiring, including motor starters and disconnects, serving the unit has been completed.
  - 6. All automatic temperature and safety controls have been completed.
  - 7. All dampers are fully operational.
  - 8. All shipping materials have been removed.
  - 9. All (clean) filter media has been installed in the units.
- G. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.
- H. Connect hydronic coils to supply and return piping. Install ball valve in supply branch and ball valve and pressure independent control valve in return branch piping. Install manual air vents at high points and drain valves at low points and as required for maintenance.

### 3.5 LEVELING

- A. The Mechanical Contractor shall level all unit sections in accordance with the unit manufacturer's instructions. The Mechanical Contractor shall provide and install all necessary permanent shim material to ensure individual sections and entire assembled units are level.

### 3.6 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

### 3.7 FINAL INSPECTION AND START UP SERVICE

- A. After the Mechanical Contractor has provided all water and steam piping connections, ductwork connections, and field control wiring, and Electrical Contractor has provided all the field power wiring, the Mechanical Contractor shall inspect the installation. The AHU Manufacturer shall then perform startup of the equipment.
- B. The Automatic Temperature Control (Building Direct Digital Control) Contractor shall be scheduled to be at the job site at the time of the equipment start up.
- C. The Mechanical Contractor, shall perform the following tests and services and submit a report outlining the results:
  - 1. Record date, time, and person(s) performing service.
  - 2. Lubricate all moving parts.
  - 3. Check all motor and starter power lugs and tighten as required.
  - 4. Verify all electrical power connections.
  - 5. Conduct a start up inspection per the AHU manufacturer's recommendations.
  - 6. Record fan motor voltage and amperage readings.
  - 7. Check fan rotation and spin wheel to verify that rotation is free and does not rub or bind.
  - 8. Check fan for excessive vibration.
  - 9. Check V belt drive or coupling for proper alignment.
  - 10. Check V belt drive for proper tension. Tighten the belts in accordance with the AHU manufacturer's directions. Check belt tension during the second and seventh day's operation and re-adjust belts, as may be required, to maintain proper tension as directed by the AHU manufacturer.
  - 11. Remove all foreign loose material in ductwork leading to and from the fan and in the fan itself.
  - 12. Disengage all shipping fasteners on vibration isolation equipment.
  - 13. Check safety guards to insure they are properly secured.

14. Secure all access doors to the fan, the unit and the ductwork.
15. Switch electrical supply "on" and allow fan to reach full speed.
16. Physically check each fan at start up and shut down to insure no abnormal or problem conditions exist.
17. Check entering and leaving air temperatures (dry bulb and wet bulb) and simultaneously record entering and leaving chilled water temperatures and flow, steam pressures and flow, and outside air temperature.
18. Check all control sequences.

### 3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237313



## SECTION 237401 - PACKAGED ROOFTOP HEATING AND COOLING UNITS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes packaged rooftop heating and cooling units with the following components and accessories:
  - 1. Direct-expansion cooling.
  - 2. Economizer outdoor- and return-air damper section.
  - 3. Power exhaust.
  - 4. Integral space temperature control systems.
  - 5. Roof curbs.
  - 6. Energy recovery wheel with bypass damper.

#### 1.2 SUBMITTALS

- A. Product Data: Literature shall be provided that indicates dimensions, operating and shipping weights, capacities, ratings, fan performance, filter information, factory supplied accessories, electrical characteristics and connection requirements. Installation, Operation and Maintenance manual with startup requirements shall be provided.
- B. Shop Drawings: Unit drawings shall be provided that indicate assembly, unit dimensions, construction details, clearances, and connection details. Computer generated fan curves for each fan shall be submitted with specific design operation point noted. Wiring diagram shall be provided with details for both power and control systems and differentiate between factory installed and field installed wiring.
- C. Startup Forms.
- D. Manufacturer's warranties as specified. Include documentation of original shipment date from the factory and the date(s) of substantial completion.
- E. Installation, Operation and Maintenance Manual.

#### 1.3 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. Fan Belts: One set for each belt-driven fan.
  - 2. Filters: Two sets of filters for each unit.

#### 1.4 QUALITY ASSURANCE

- A. Packaged air-cooled condenser units shall be certified in accordance with ANSI/AHRI Standard 340/360 performance rating of commercial and industrial unitary air-conditioning and heat pump equipment.
- B. Unit and refrigeration system shall comply with ASHRAE 15, Safety Standard for Mechanical Refrigeration.
- C. Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.
- D. Unit shall be certified in accordance with ANSI Z21.47b/CSA 2.3b and ANSI Z83.8/CSA 2.6, Safety Standard Gas-Fired Furnaces.
- E. Unit Energy Efficiency Ratio (EER) shall be equal to or greater than prescribed by ASHRAE 90.1, Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.
- F. Unit shall be safety certified by ETL and be ETL US and ETL Canada listed. Unit nameplate shall include the ETL/ETL Canada label.

#### 1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components within specified warranty period.
  - 1. Warranty Period for Compressors: 5 years from date of Substantial Completion.

### PART 2 PRODUCTS

#### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with specifications, provide a product by one of the following:
  - 1. AAON
  - 2. Daikin
  - 3. York
  - 4. Trane

#### 2.2 GENERAL DESCRIPTION

- A. Packaged rooftop unit shall include compressors, evaporator coils, filters, supply fans, dampers, air-cooled condenser coils, condenser fans, reheat coil, energy recovery, exhaust fans, and unit controls.

- B. Unit shall be factory assembled and tested including leak testing of the coils, pressure testing of the refrigeration circuit, and run testing of the completed unit. Run test report shall be supplied with the unit in the controls compartment's literature pocket.
- C. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.
- D. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.
- E. Estimated sound power levels (dB) shall be shown on the unit ratings sheet.
- F. Installation, Operation and Maintenance manual shall be supplied within the unit.
- G. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's access door.
- H. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's access door.

## 2.3 CONSTRUCTION

- A. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.
- B. Unit insulation shall have a minimum thermal resistance R-value of 13. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D-1929 for a minimum flash ignition temperature of 610°F.
- C. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, prevents heat transfer through the panel, and prevents exterior condensation on the panel.
- D. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Cabinet leakage shall not exceed 1% of total airflow when tested at 3 times the minimum external static pressure provided in AHRI Standard 340/360. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, at a maximum 8 inches of positive or negative static pressure, to reduce air leakage. Deflection shall be measured at the midpoint of the panel height and width. Continuous sealing shall be included between panels and between access doors and openings to reduce air leakage. Refrigerant piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.
- E. Roof of the air tunnel shall be sloped to provide complete drainage. Cabinet shall have rain break overhangs above access doors.

- F. Access to filters, dampers, cooling coils, reheat coil, heaters, exhaust fans, return fans, energy recovery wheels, compressors, water-cooled condensers, and electrical and controls components shall be through hinged access doors with quarter turn, zinc cast, lockable handles. Full-length stainless-steel piano hinges shall be included on the doors.
- G. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
- H. Units with cooling coils shall include double sloped 304 stainless steel drain pans with 1/2-inch-thick foam insulation.
- I. Unit shall be provided with base discharge and return air openings. All openings through the base pan of the unit shall have upturned flanges of at least 1/2 inch in height around the opening.
- J. Unit shall include lifting lugs on the top of the unit.

## 2.4 ELECTRICAL

- A. Unit shall be provided with standard power block for connecting power to the unit.
  - 1. Unit shall be provided with factory installed and factory wired, non-fused disconnect switch.
  - 2. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more that 10% out of balance on voltage, the voltage is more that 10% under design voltage, or on phase reversal.
- B. Unit shall be provided with a terminal block for field installation of a fire alarm shutdown relay which shuts off the unit's control circuit.

## 2.5 SUPPLY FANS

- A. Unit shall include belt driven, forward curved, centrifugal fans with fixed motor sheaves.
- B. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.
- C. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
  - 1. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency. VFDs shall include bypass control.

## 2.6 EXHAUST FANS

- A. Exhaust dampers shall be sized for 100% relief.

- B. Fans and motors shall be dynamically balanced.
- C. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
- D. Access to exhaust fans shall be through double wall, hinged access doors with quarter turn handles.
  - 1. Variable frequency drives shall be factory wired and mounted in the unit. Fan motors shall be premium efficiency.

## 2.7 COOLING COILS

- A. Evaporator Coils
  - 1. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and galvanized steel end casings. Fin design shall be sine wave rippled.
  - 2. Coils shall have interlaced circuitry and shall be standard capacity.
  - 3. Coils shall be helium leak tested.
  - 4. Coils shall be furnished with a factory installed thermostatic expansion valves.

## 2.8 REFRIGERATION SYSTEM

- A. Unit shall be factory charged with R-410A refrigerant.
- B. Compressors shall be scroll type with thermal overload protection, independently circuited, and carry a 5-year non-prorated warranty, from the date of original equipment shipment from the factory.
- C. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam insulated panels to prevent the transmission of noise outside the cabinet.
- D. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
- E. Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.
- F. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low-pressure sides, and factory installed liquid line filter driers.
- G. Unit shall include Digital scroll compressor on the lead circuit.

1. Unit shall include a variable capacity scroll compressor on the lead refrigeration circuit(s) which shall be capable of modulation from 10-100% of its capacity.
2. Lead refrigeration circuit shall be provided with hot gas reheat coil, modulating valves, electronic controller, supply air temperature sensor and a dehumidification control signal terminal which allow the unit to have a dehumidification mode of operation, which includes supply air temperature control to prevent supply air temperature swings and overcooling of the space.
3. Each refrigeration circuit shall be equipped with a liquid line sight glass.
4. Each refrigeration circuit shall be equipped with suction and discharge compressor isolation valves.

## 2.9 CONDENSERS

### A. Air-Cooled Condenser

1. Condenser fans shall be vertical discharge, axial flow, direct drive fans.
2. Coils shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
3. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.
4. Coils shall be helium leak tested.

## 2.10 FILTERS

- A. Unit shall include 2-inch thick, pleated panel filters with a MERV rating of 13, upstream of the cooling coil.
- B. Unit shall include a clogged filter switch.

## 2.11 OUTSIDE AIR/ECONOMIZER

- A. Unit shall include 0-100% ultra-low leak economizer with differential enthalpy control consisting of a motor operated outside air damper and return air damper assembly constructed of extruded aluminum, hollow core, airfoil blades with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 3 CFM of leakage per sq. ft. of damper area when subjected to 1-inch w.g. air pressure differential across the damper. Damper assembly shall be controlled by spring return wet bulb activated fully modulating. Unit shall include outside air opening bird screen, outside air hood and 100% power exhaust fan.
  1. An airflow station shall be provided in the outside air opening to measure airflow. See Paragraph 2.15 for additional information.

## 2.12 CONTROLS

- A. Factory Installed and Factory Provided Controller

1. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.
  2. Controller shall be capable of standalone operation with unit configuration, set point adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
  3. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
  4. Controller shall include non-volatile memory to retain all programmed values, without the use of an external battery, in the event of a power failure.
- B. Single Zone Variable Air Volume Controller
1. Single zone VAV option shall be provided with all necessary controls to operate a rooftop unit based on maintaining two temperature setpoints; the discharge air and zone. Option shall include factory-installed variable frequency drive (VFD) to provide supply fan motor speed modulation. During One Zone VAV cooling, the unit will maintain zone cooling setpoint by modulating the supply fan speed more or less to meet zone load demand, and the unit will maintain discharge temperature to the discharge cooling setpoint by modulating economizer if available and staging dx cooling.
- C. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit.

## 2.13 ROOF CURBS

- A. Curbs shall be fully gasketed between the curb top and unit bottom with the curb providing full perimeter support, cross structure support and air seal for the unit. Curb gasket shall be furnished within the control compartment of the rooftop unit to be mounted on the curb immediately before mounting of the rooftop unit.
1. Material: ASTM A 653 G90 hot dipped galvanized steel.
    - a. Minimum 18 Gauge, and as engineered by manufacturer.
  2. Corners: Mitered and welded (welds shall be micro sealed and prime painted after fabrication). Bolted connections not accepted.
  3. Base Plates: Integral to frame.
  4. Wood Nailers: Factory installed; pressure treated. Size and width as suitable for support of items installed on curbs.
  5. Insulation: Factory installed 1 ½ inch three-pound density fiberglass insulation.
  6. Curb Height: 24 inch above deck.
  7. Gasketing: 1/4-inch-thick, 1 inch wide.

8. Duct supports: Gauge of material as required per curb manufacturer.

## 2.14 AIRFLOW MEASUREMENT DEVICES

### A. General

1. Sensors shall be located in the following locations:
  - a. Provide Type 2 fan inlet flow stations in the supply fans of RTU-1.
  - b. Provide Type 3 outdoor air measuring devices in RTU-1.

### B. Manufacturers

1. Subject to compliance with performance and design requirements of this Section, provide products that comply with this specification by one of the following vendors:
  - a. EBTRON, Inc. (Basis of design)
  - b. Kurz Instruments
  - c. Fluid Components International (FCI)

### C. Airflow Measurement Devices (AMD) with Temperature Output and Airflow Alarming Capability

1. Type 1: Duct or plenum flow stations for airflow measurement, temperature and alarm capability.
  - a. EBTRON Model GTx116-P+
2. Type 2: Fan inlet flow stations for airflow measurement with, temperature and alarm capability.
  - a. Sensor housings shall be mounted on 304 stainless steel blocks.
  - b. Mounting rods shall be field adjustable to fit inlet and constructed of nickel-plated steel.
  - c. Mounting feet shall be constructed of 304 stainless steel.
  - d. The operating airflow range shall be 0 to 10,000 FPM unless otherwise indicated on the plans.
  - e. EBTRON Model GTx108-F
3. Type 3: Rooftop Unit Outside Air Measuring Devices.
  - a. Provide monitor/controller capable of direct air measurement of airflow through an outside air inlet and produce dual outputs; one representing the measuring airflow. And the other to control the inlet damper.
  - b. The monitor/controller shall contain an integral multi-line liquid crystal display for use during the configuration and calibration processes, and to display two measured processes (volume, velocity, temperature) during normal operation. All configuration, output scaling, calibration, and controller tuning will be performed digitally in the on-board microprocessor via input pushbuttons.



- c. The monitor/controller shall measure inlet airflow with an accuracy of +/- 5% of reading over a range of 150-600fpm, 500-2000fpm and not have its reading affected by the presence of directional or gusting variances, and atmospheric due to site altitude.
- d. The monitor/controller shall interface with the building automation system, accepting inputs for fan system start, economizer mode operation, and an external controller setpoint, and provide flow deviation alarm outputs.
- e. The sensors shall be constructed of materials that resist corrosion due to the presence of salt or chemicals in the air; all non-painted surfaces shall be constructed of stainless steel. The electronics enclosure shall be NEMA 4.
- f. The outside reference sensor shall be located upstream of and mounted in the center of the intake louver or fixed resistance device.
- g. The outside reference sensor shall be located upstream of and mounted in the center of the intake louver or fixed resistance device.
- h. The inlet airflow sensor shall be located downstream of any inlet louver or fixed resistance device, and upstream of the outside air intake control damper.
- i. The outside air measuring station shall be positioned upstream of the outside air intake control damper.
- j. EBTRON Model GTx116-P+

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.
- B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.
- C. Examine roofs for suitable conditions where RTUs will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Install unit, including field installed components, in accordance with Installation, Operation and Maintenance manual instructions.

#### 3.3 ROOF CURBS

- A. Coordinate roof openings and structural steel supports and placement.

- B. Fasten roof curb to blocking.
- C. Install 3" thick Thermafiber SAFB 2.5 PCF inside curb above roof deck. Cover with 2 layers of 5/8" Type X GWB with staggered joints. Install 2" rigid fiberglass board insulation with FSK jacket above GWB and on inside face of roof curb. Fill gaps and joints around curb perimeter, conduits and ductwork with acoustical sealant. Arrange for inspection by Engineer prior to setting RTU's.

### 3.4 CONNECTIONS

- A. Provide Type DWV copper condensate drain same size as unit connection with minimum 2" deep trap seal. Provide trap drain plug and cleanout.
- B. Provide access for installation of gas piping, power and control raceways through inside of curb. Comply with manufacturer's instructions for final connections.
- C. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:
  - 1. Install ducts to termination at top of roof curb.
  - 2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.
  - 3. Install return-air duct continuously through roof structure.

### 3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Perform startup in accordance with manufacturer's instructions.
  - 2. Prepare complete startup report/form included in manufacturer's IOM manual for each unit. Submit completed Startup Forms in PDF format.
  - 3. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

### 3.6 DEMONSTRATION

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

END OF SECTION

## SECTION 238129 - VARIABLE REFRIGERANT-FLOW HVAC 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 complete VRF HVAC system(s) including, but not limited to the following components to make a complete operating system(s) according to requirements indicated:
  - 1. Indoor, concealed, ceiling-mounted units for ducting.
  - 2. Indoor, recessed, ceiling-mounted units.
  - 3. Indoor, exposed, wall-mounted units.
  - 4. Outdoor, air-source, heat-pump units.
  - 5. System controls.
  - 6. System refrigerant and oil.
  - 7. System control cable and raceways.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for indoor and outdoor units.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
  - 3. Include operating performance at design conditions and at extreme maximum and minimum outdoor ambient conditions.
  - 4. Include description of system controllers, dimensions, features, control interfaces and connections, power requirements, and connections.
  - 5. Include system operating sequence of operation in narrative form for each unique indoor- and outdoor-unit control.
  - 6. Include description of control software features.
  - 7. Include total refrigerant required and a comprehensive breakdown of refrigerant required by each system installed.
  - 8. Include refrigerant type and data sheets showing compliance with requirements indicated.
  - 9. For system design software.

10. Indicate location and type of service access.

B. Shop Drawings: For VRF HVAC systems.

1. Include plans, elevations, sections, and mounting details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams and details of refrigerant piping and tubing showing installation requirements for manufacturer-furnished divided flow fittings.
4. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data:

1. For Installer: Certificate from VRF HVAC system manufacturer certifying that Installer has successfully completed prerequisite training administered by manufacturer for proper installation of systems, including but not limited to, equipment, piping, controls, and accessories indicated and furnished for installation.
  - a. Retain copies of Installer certificates on-site and make available on request.
2. For VRF HVAC system manufacturer.
3. For VRF HVAC system provider.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For VRF HVAC systems to include in emergency, operation, and maintenance manuals.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store products in a clean and dry place.
- B. Comply with manufacturer's written rigging and installation instructions for unloading and moving to final installed location.
- C. Handle products carefully to prevent damage, breaking, denting, and scoring. Do not install damaged products.
- D. Protect products from weather, dirt, dust, water, construction debris, and physical damage.
1. Retain factory-applied coverings on equipment to protect finishes during construction and remove just prior to operating unit.

2. Cover unit openings before installation to prevent dirt and dust from entering inside of units. If required to remove coverings during unit installation, reapply coverings over openings after unit installation and remove just prior to operating unit.
- E. Replace installed products damaged during construction.

## 1.7 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace equipment and components that fail(s) in materials or workmanship within specified warranty period.
  1. Failures include, but are not limited to, the following:
    - a. Structural failures.
    - b. Faulty operation.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
  2. Warranty Period:
    - a. For Compressor: Seven year(s) from date of Substantial Completion.
    - b. For Parts, Including Controls: 10 year(s) from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Hitachi. (Basis of Design)
  2. Samsung HVAC.
  3. Daikin.

### 2.2 SYSTEM DESCRIPTION

- A. Direct-expansion (DX) VRF HVAC system(s) with variable capacity in response to varying cooling and heating loads. System shall consist of multiple indoor units, outdoor unit(s), piping, controls, and electrical power to make complete operating system(s) complying with requirements indicated.
  1. System(s) operation, heat pump as indicated on Drawings.
  2. Each system with one refrigerant circuit shared by all indoor units connected to system.
- 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. AHRI Compliance: System and equipment performance certified according to AHRI 1230 and products listed in AHRI directory.
- D. ASHRAE Compliance:
  - 1. ASHRAE/IES 90.1 Compliance: For system and component energy efficiency.
- E. UL Compliance: Comply with UL 1995.

## 2.3 INDOOR, CONCEALED, CEILING-MOUNTED UNITS FOR DUCTING

- A. Description: Factory-assembled complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.
- B. Cabinet:
  - 1. Material: Galvanized or painted steel.
  - 2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
  - 3. Duct Connections: Extended collar or flange, or designated exterior cabinet surface, designed for attaching field-installed ductwork.
  - 4. Mounting: Manufacturer-designed provisions for field installation.
  - 5. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
- C. DX Coil Assembly:
  - 1. Coil Casing: Aluminum, galvanized, or stainless steel.
  - 2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
  - 3. Coil Tubes: Copper, of diameter and thickness required by performance.
  - 4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
  - 5. Unit Internal Tubing: Copper tubing with brazed joints.
  - 6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
  - 7. Field Piping Connections: Manufacturer's standard.
  - 8. Factory Charge: Dehydrated air or nitrogen.
  - 9. Testing: Factory pressure tested and verified to be without leaks.
- D. Drain Assembly:
  - 1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
  - 2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
  - 3. Field Piping Connection: Non-ferrous material with threaded NPT.
- E. Fan and Motor Assembly:
  - 1. Fan(s):

- a. Direct-drive arrangement.
  - b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
  - c. Fabricated from non-ferrous components or ferrous components with corrosion-resistant finish.
  - d. Wheels statically and dynamically balanced.
2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
5. Vibration Control: Integral isolation to dampen vibration transmission.
- F. Filter Assembly:
  1. Access: Bottom, side, or rear to accommodate field installation without removing ductwork and to accommodate filter replacement without need for tools.
  2. Efficiency: ASHRAE 52.2, MERV 13
  3. Media:
    - a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.
- G. Unit Controls:
  1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
  2. Field-Installed Controller: Hardwired.
  3. Features and Functions: Self-diagnostics, time delay, auto-restart, auto operation mode, manual operation mode, filter service notification.
  4. Communication: Network communication with other indoor units and outdoor unit(s).
- H. Unit Electrical:
  1. Enclosure: Metal, suitable for indoor locations.
  2. Field Connection: Single point connection to power unit and integral controls.
  3. Disconnecting Means: Factory-mounted circuit breaker or switch.
  4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
  5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
  6. Raceways: Enclose line voltage wiring in metal raceways.

## 2.4 INDOOR, RECESSED, CEILING-MOUNTED UNITS

- A. Description: Factory-assembled complete unit with components, piping, wiring, and controls required for mating to ductwork, piping, power, and controls field connections.
- B. Cabinet:
  - 1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
  - 2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
  - 3. Mounting: Manufacturer-designed provisions for field installation.
  - 4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
- C. DX Coil Assembly:
  - 1. Coil Casing: Aluminum, galvanized, or stainless steel.
  - 2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
  - 3. Coil Tubes: Copper, of diameter and thickness required by performance.
  - 4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
  - 5. Internal Tubing: Copper tubing with brazed joints.
  - 6. Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
  - 7. Field Piping Connections: Manufacturer's standard.
  - 8. Factory Charge: Dehydrated air or nitrogen.
  - 9. Testing: Factory pressure tested and verified to be without leaks.
- D. Drain Assembly:
  - 1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
  - 2. Condensate Removal: Unit-mounted pump or other integral lifting mechanism, capable of lifting drain water to an elevation above top of cabinet.
  - 3. Field Piping Connection: Non-ferrous material with threaded NPT.
- E. Fan and Motor Assembly:
  - 1. Fan(s):
    - a. Direct-drive arrangement.
    - b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
    - c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
    - d. Wheels statically and dynamically balanced.
  - 2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.



3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
  4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
  5. Vibration Control: Integral isolation to dampen vibration transmission.
- F. Filter Assembly:
1. Access: Bottom, to accommodate filter replacement without the need for tools.
  2. Media:
    - a. Replaceable: Extended surface, panel, or cartridge with antimicrobial treatment fiber media.
    - b. Washable: Manufacturer's standard filter with antimicrobial treatment.
- G. Discharge-Air Grille Assembly: Mounted in bottom of unit cabinet.
1. Discharge Pattern: One-, two-, three-, or four-way throw as indicated on Drawings.
    - a. Discharge Pattern Adjustment: Field-adjustable limits for up and down range of motion.
    - b. Discharge Pattern Closure: Ability to close individual discharges of units with multiple patterns.
  2. Motorized Vanes: Modulating up and down flow pattern for uniform room air distribution.
- H. Return-Air Grille Assembly: Manufacturer's standard grille mounted in bottom of unit cabinet.
- I. Outdoor Air Ventilation Connection: Sheet metal knockout for optional connection to outdoor air ventilation duct.
- J. Unit Accessories:
1. Remote Controller: Wall-mounted, hardwired remote controller.
  2. Condensate Pump: Integral reservoir and control with electrical power connection through unit power.
- K. Unit Controls:
1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
  2. Field-Installed Controller: Hardwired.
  3. Features and Functions: Self-diagnostics, time delay, auto-restart, auto operation mode, manual operation mode, filter service notification.
  4. Communication: Network communication with other indoor units and outdoor unit(s).
- L. Unit Electrical:
1. Enclosure: Manufacturer's standard, and suitable for indoor locations.

2. Field Connection: Single point connection to power entire unit and integral controls.
3. Disconnecting Means: Field installed disconnect switch furnished and installed by Electrical Contractor.
4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.

## 2.5 INDOOR, EXPOSED, WALL-MOUNTED UNITS

- A. Description: Factory-assembled complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
- B. Cabinet:
  1. Material: Painted steel, or coated steel frame covered by a plastic cabinet, with an architectural acceptable finish suitable for tenant occupancy on exposed surfaces.
  2. Insulation: Manufacturer's standard internal insulation, complying with ASHRAE 62.1, to provide thermal resistance and prevent condensation.
  3. Mounting: Manufacturer-designed provisions for field installation.
  4. Internal Access: Removable panels of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
- C. DX Coil Assembly:
  1. Coil Casing: Aluminum, galvanized, or stainless steel.
  2. Coil Fins: Aluminum, mechanically bonded to tubes, with arrangement required by performance.
  3. Coil Tubes: Copper, of diameter and thickness required by performance.
  4. Expansion Valve: Electronic modulating type with linear or proportional characteristics.
  5. Unit Internal Tubing: Copper tubing with brazed joints.
  6. Unit Internal Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
  7. Field Piping Connections: Manufacturer's standard.
  8. Factory Charge: Dehydrated air or nitrogen.
  9. Testing: Factory pressure tested and verified to be without leaks.
- D. Drain Assembly:
  1. Pan: Non-ferrous material, with bottom sloped to low point drain connection.
  2. Condensate Removal: Gravity.
    - a. If a floor drain is not available at unit, provide unit with field-installed condensate pump accessory.
  3. Field Piping Connection: Non-ferrous material with threaded NPT.
- E. Fan and Motor Assembly:

1. Fan(s):
    - a. Direct-drive arrangement.
    - b. Single or multiple fans connected to a common motor shaft and driven by a single motor.
    - c. Fabricated from non-ferrous components or ferrous components with corrosion protection finish.
    - d. Wheels statically and dynamically balanced.
  2. Motor: Brushless dc or electronically commutated with permanently lubricated bearings.
  3. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
  4. Speed Settings and Control: Two (low, high), three (low, medium, high), or more than three speed settings or variable speed with a speed range of least 50 percent.
  5. Vibration Control: Integral isolation to dampen vibration transmission.
- F. Filter Assembly:
1. Access: Front, to accommodate filter replacement without the need for tools.
  2. Washable Media: Manufacturer's standard filter with antimicrobial treatment.
- G. Grille Assembly: Manufacturer's standard discharge grille with field-adjustable air pattern mounted in top or front face of unit cabinet.
- H. Unit Accessories:
1. Remote Room Temperature Sensor Kit: Wall-mounted, hardwired room temperature sensor kit for use in rooms that do not have room temperature measurement.
  2. Condensate Pump: Integral reservoir and control with electrical power connection through unit power.
- I. Unit Controls:
1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
  2. Field-Installed Controller: Hardwired.
  3. Features and Functions: Self-diagnostics, time delay, auto-restart, auto operation mode, manual operation mode, filter service notification.
  4. Communication: Network communication with other indoor units and outdoor unit(s).
- J. Unit Electrical:
1. Enclosure: Manufacturer's standard, and suitable for indoor locations.
  2. Field Connection: Single point connection to power entire unit and integral controls.
  3. Disconnecting Means: Factory-mounted circuit breaker or switch, complying with NFPA 70.

4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
5. Wiring: Manufacturer's standard with each connection labeled and corresponding to a unit-mounted wiring diagram.
6. Raceways: Enclose line voltage wiring in metal raceways to comply with NFPA 70.

## 2.6 OUTDOOR, AIR-SOURCE HEAT-PUMP UNITS

- A. Description: Factory-assembled and -tested complete unit with components, piping, wiring, and controls required for mating to piping, power, and controls field connections.
  1. Specially designed for use in systems with either all heating or all cooling demands, but not for use in systems with simultaneous heating and cooling.
  2. Systems shall consist of one unit, or multiple unit modules that are designed by variable refrigerant system manufacturer for field interconnection to make a single refrigeration circuit that connects multiple indoor units.
  3. All units installed shall be from the same product development generation.
- B. Cabinet:
  1. Galvanized steel and coated with a corrosion-resistant finish.
  2. Mounting: Manufacturer-designed provisions for field installation.
  3. Internal Access: Removable panels or hinged doors of adequate size for field access to internal components for inspection, cleaning, service, and replacement.
- C. Compressor and Motor Assembly:
  1. One or more positive-displacement, direct-drive and hermetically sealed scroll compressor(s) with inverter drive and turndown to 15 percent of rated capacity or lower.
  2. Speed Control: Variable to automatically maintain refrigerant suction and condensing pressures while varying refrigerant flow to satisfy system cooling and heating loads.
  3. Vibration Control: Integral isolation to dampen vibration transmission.
  4. Oil management system to ensure safe and proper lubrication over entire operating range.
  5. Crankcase heaters with integral control to maintain safe operating temperature.
  6. Fusible plug.
- D. Condenser Coil Assembly:
  1. Plate Fin Coils:
    - a. Casing: Aluminum, galvanized, or stainless steel.
    - b. Fins: Aluminum or copper, mechanically bonded to tubes, with arrangement required by performance.
    - c. Tubes: Copper, of diameter and thickness required by performance.

- E. Condenser Fan and Motor Assembly:
  - 1. Fan(s): Propeller type.
    - a. Direct-drive arrangement.
    - b. Fabricated from non-ferrous components or ferrous components with corrosion protection finish to match performance indicated for condenser coil.
    - c. Statically and dynamically balanced.
  - 2. Fan Guards: Removable safety guards complying with OSHA regulations. If using metal materials, coat with corrosion-resistant coating to match performance indicated for condenser coil.
  - 3. Motor(s): Brushless dc or electronically commutated with permanently lubricated bearings and rated for outdoor duty.
  - 4. Motor Protection: Integral protection against thermal, overload, and voltage fluctuations.
  - 5. Speed Settings and Control: Variable speed with a speed range of least 75 percent.
  - 6. Vibration Control: Integral isolation to dampen vibration transmission.
- F. Drain Pan: If required by manufacturer's design, provide unit with non-ferrous drain pan with bottom sloped to a low point drain connection.
- G. Unit Controls:
  - 1. Enclosure: Manufacturer's standard, and suitable for unprotected outdoor locations.
  - 2. Field Installed Controller: Hardwired.
  - 3. Features and Functions: Self-diagnostics, time delay, auto-restart, auto operation mode, manual operation mode, filter service notification.
  - 4. Communication: Network communication with indoor units and other outdoor unit(s).
- H. Unit Electrical:
  - 1. Enclosure: Metal, similar to enclosure, and suitable for unprotected outdoor locations.
  - 2. Field Connection: Single point connection to power entire unit and integral controls.
  - 3. Disconnecting Means: Field installed disconnect switch furnished and installed by Electrical Contractor.
  - 4. Control Transformer: Manufacturer's standard. Coordinate requirements with field power supply.
  - 5. Raceways: Enclose line voltage wiring in raceways to comply with NFPA 70.
- I. Unit Hardware: Zinc-plated steel, or stainless steel.
- J. Unit Piping:

1. Unit Tubing: Copper tubing with brazed joints.
2. Unit Tubing Insulation: Manufacturer's standard insulation, of thickness to prevent condensation.
3. Field Piping Connections: Manufacturer's standard.
4. Factory Charge: Dehydrated air or nitrogen.
5. Testing: Factory pressure tested and verified to be without leaks.

## 2.7 SYSTEM CONTROLS

### A. General Requirements:

1. Network: Indoor units and outdoor units shall include integral controls and connect through a TIA-485A control network.
2. Network Communication Protocol: Open control communication between interconnected units.
3. Integration with Building Automation System: ASHRAE 135, BACnet IP and certified by BACnet Testing Lab (BTL), including the following:
  - a. Ethernet connection via RJ-45 connectors and port with transmission at 100 Mbps or higher.

### B. Central Controllers:

1. Centralized control for all indoor and outdoor units from a single central controller location.
  - a. Include multiple interconnected controllers as required.
2. Controls operation mode of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units. Operation modes available through central controller shall match those operation modes of controllers for indoor units.
3. Schedule operation of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
  - a. Sets schedule for daily, weekly, and annual events.
  - b. Schedule options available through central controller shall at least include the schedule options of controllers for indoor units.
4. Changes operating set points of indoor units as individual units, by selected groups of indoor units, or as collection of all indoor units.
5. Optimized start feature to start indoor units before scheduled time to reach temperature set-point at scheduled time based on operating history.
6. Night setback feature to operate indoor units at energy-conserving heating and cooling temperature set-points during unoccupied periods.
7. Service diagnostics tool.
8. Able to disable and enable operation of individual controllers for indoor units.
9. Information displayed on individual controllers shall also be available for display through central controller.

10. Information displayed for outdoor units, including refrigerant high and low pressures.
11. Multiple RJ-45 ports for direct connection to a local PC and an Ethernet network switch.
12. Operator interface through a backlit, high-resolution color display touch panel and web accessible through standard web browser software.

C. Wired Controllers for Indoor Units:

1. Single controller capable of controlling multiple indoor units as group.
2. Auto Timeout Touch Screen LCD: Timeout duration shall be adjustable.
3. Temperature Units: Fahrenheit.
4. On/Off: Turns indoor unit on or off.
5. Hold: Hold operation settings until hold is released.
6. Operation Mode: Cool, Heat, Auto, Dehumidification, Fan Only, and Setback.
7. Temperature Display: 1-degree increments.
8. Temperature Set-Point: Separate set points for Cooling, Heating, and Setback. Adjustable in 1-degree increments.
9. Relative Humidity Display: 1 percent increments.
10. Relative Humidity Set-Point: Adjustable in 1 percent increments.
11. Fan Speed Setting: Select between available options furnished with the unit.
12. Airflow Direction Setting: If applicable to unit, select between available options furnished with the unit.
13. Seven-day programmable operating schedule with up to five events per day. Operations shall include On/Off, Operation Mode, and Temperature Set-Point.
14. Auto Off Timer: Operates unit for an adjustable time duration and then turns unit off.
15. Occupancy detection.
16. Service Notification Display: "Filter"
17. Service Run Tests: Limit use by service personnel to troubleshoot operation.
18. Error Code Notification Display: Used by service personnel to troubleshoot abnormal operation and equipment failure.
19. User and Service Passwords: Capable of preventing adjustments by unauthorized users.
20. Setting stored in nonvolatile memory to ensure that settings are not lost if power is lost. Battery backup for date and time only.
21. Low-voltage power required for controller shall be powered through non-polar connections to indoor unit.

## 2.8 SYSTEM REFRIGERANT AND OIL

A. Refrigerant:

1. As required by VRF HVAC system manufacturer for system to comply with performance requirements indicated.

2. ASHRAE 34, Class A1 refrigerant classification.
  3. R-410a.
- B. Oil:
1. As required by VRF HVAC system manufacturer and to comply with performance requirements indicated.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine products before installation. Reject products that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for piping and tubing to verify actual locations of connections before equipment installation.
- D. Examine roughing-in for wiring and conduit to verify actual locations of connections before equipment installation.
- E. Examine walls, floors, roofs, and outdoor pads for suitable conditions where equipment will be installed.
- F. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- G. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 EQUIPMENT INSTALLATION, GENERAL

- A. Clearance:
  1. Maintain manufacturer's recommended clearances for service and maintenance.
  2. Maintain clearances required by governing code.
- B. Loose Components: Install components, devices, and accessories furnished by manufacturer, with equipment, that are not factory mounted.
  1. Loose components shall be installed by system Installer under supervision of manufacturer's service representative.

### 3.3 INSTALLATION OF INDOOR UNITS

- A. Install units to be level and plumb while providing a neat and finished appearance.



- B. Unless otherwise required by VRF HVAC system manufacturer, support ceiling-mounted units from structure above using threaded rods; minimum rod size of 3/8 inch.
- C. Adjust supports of exposed and recessed units to draw units tight to adjoining surfaces.
- D. Protect finished surfaces of ceilings, floors, and walls that come in direct contact with units. Refinish or replaced damaged areas after units are installed.
- E. In rooms with ceilings, conceal piping and tubing, controls, and electrical power serving units above ceilings.
- F. In rooms without ceiling, arrange piping and tubing, controls, and electrical power serving units to provide a neat and finished appearance.
- G. Provide lateral bracing if needed to limit movement of suspended units to not more than 0.25 inch.
- H. For wall-mounted units that are exposed, conceal piping and tubing, controls, and electrical power serving units within walls.
- I. Attachment: Install hardware for proper attachment to supported equipment.

### 3.4 INSTALLATION OF OUTDOOR UNITS

- A. Install units to be level and plumb while providing a neat and finished appearance.
- B. Install outdoor units on support structures indicated on Drawings.
- C. Roof-Mounted Installations: Install outdoor units on equipment supports typical of nVent CADDY Pyramid or acceptable equal. Anchor units to supports with removable, stainless-steel fasteners.

### 3.5 GENERAL REQUIREMENTS FOR PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping and tubing systems. Install piping and tubing as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping and tubing in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping and tubing at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping and tubing above accessible ceilings to allow sufficient space for ceiling panel removal.

- E. Install piping and tubing to permit valve servicing.
- F. Install piping and tubing at indicated slopes.
- G. Install piping and tubing free of sags.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping and tubing to allow application of insulation.
- J. Install groups of pipes and tubing parallel to each other, spaced to permit applying insulation with service access between insulated piping and tubing.
- K. Install sleeves for piping and tubing penetrations of walls, ceilings, and floors.
- L. Install escutcheons for piping and tubing penetrations of walls, ceilings, and floors.

### 3.6 INSTALLATION OF SYSTEM CONDENSATE DRAIN PIPING

- A. General Requirements for Drain Piping and Tubing:
  - 1. Install a union in piping at each threaded unit connection.
  - 2. Install an adjustable stainless-steel hose clamp with adjustable gear operator on unit hose connections. Tighten clamp to provide a leak-free installation.
  - 3. If required for unit installation, provide a trap assembly in drain piping to prevent air circulated through unit from passing through drain piping. Comply with more stringent of the following:
    - a. Details indicated on Drawings.
    - b. Manufacturer's requirements.
    - c. Governing codes.
    - d. In the absence of requirements, comply with requirements of ASHRAE handbooks.
  - 4. Extend drain piping from units with drain connections to drain receptors as indicated on Drawings. If not indicated on Drawings, terminate drain connection at nearest accessible location that is not exposed to view by occupants.
  - 5. Provide each 90-degree change in direction with a Y- or T-fitting. Install a threaded plug connection in the dormant side of fitting or future use as a service cleanout.
- B. Pumped Drains:
  - 1. If unit condensate pump or lift mechanism is not included with an integral check valve, install a full-size check valve in each branch pipe near unit connection to prevent backflow into unit.

### 3.7 ELECTRICAL INSTALLATION

- A. Comply with requirements indicated on Drawings and in applicable Division 26 Sections.
- B. Connect field electrical power source to each separate electrical device requiring field electrical power. Coordinate termination point and connection type with Installer.
- C. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.
- D. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding connections.
- E. Install nameplate or acrylic label with self-adhesive back for each electrical connection indicating electrical equipment designation and circuit number feeding connection.
  - 1. Nameplate shall be laminated phenolic layers of black with engraved white letters. Letters at least 1/2 inch high.
  - 2. Locate nameplate or label where easily visible.
- F. 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 revised in this Section.
- G. Install manufactured conduit sweeps and long-radius elbows if possible.
- H. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

### 3.8 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage VRF HVAC system manufacturer's service representative to advise and assist installers; witness testing; and observe and inspect components, assemblies, and equipment installations, including controls and connections.
  - 1. Field service shall be performed by a factory-trained and -authorized service representative of VRF HVAC system manufacturer whose primary job responsibilities are to provide direct technical support of its products.
- B. Perform the following tests and inspections with the assistance of manufacturer's service representative:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - C. Refrigerant Tubing Positive Pressure Testing:
    1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
    2. After completion of tubing installation, pressurize tubing systems to a test pressure of not less than 1.2 times VRF HVAC system operating pressure, but not less than 600 psig, using dry nitrogen.
    3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of 1 hour. Allowance for pressure changes attributed to changes in ambient temperature are acceptable.
    4. Submit test reports for Project record.
  - D. Refrigerant Tubing Evacuation Testing:
    1. Comply with more stringent of VRF HVAC system manufacturer's requirements and requirements indicated.
    2. After completion of tubing positive-pressure testing, evacuate tubing systems to a pressure of 500 microns.
    3. Successful testing shall maintain a test pressure for a continuous and uninterrupted period of one hour(s) with no change.
    4. Submit test reports for Project record.
    5. Upon successful completion of evacuation testing, system shall be charged with refrigerant.
  - E. System Refrigerant Charge:
    1. Using information collected from the refrigerant tubing evacuation testing, system Installer shall consult variable refrigerant system manufacturer to determine the correct system refrigerant charge.
    2. Installer shall charge system following VRF HVAC system manufacturer's written instructions.
    3. System refrigerant charging shall be witnessed by system manufacturer's representative.
    4. Total refrigerant charge shall be recorded and permanently displayed at the system's outdoor unit.
  - F. Products will be considered defective if they do not pass tests and inspections.
  - G. Prepare test and inspection reports.
- 3.9 STARTUP SERVICE
- A. Engage a VRF HVAC system manufacturer's service representative to perform system(s) startup service.

1. Service representative shall be an employee or a factory-trained and -authorized service representative of VRF HVAC system manufacturer.
  2. Complete startup service of each separate system.
  3. Complete system startup service according to manufacturer's written instructions.
- B. Installer shall accompany manufacturer's service representative during startup service and provide manufacturer's service representative with requested documentation and technical support during startup service.
1. Installer shall correct deficiencies found during startup service for reverification.
- C. System Operation Report:
1. After completion of startup service, manufacturer shall issue a report for each separate system.
  2. Report shall include complete documentation describing each startup check, the result, and any corrective action required.

### 3.10 ADJUSTING

- A. Adjust equipment and components to function smoothly and lubricate as recommended by manufacturer.
- B. Adjust initial temperature and humidity set points. Adjust initial airflow settings and discharge airflow patterns.
- C. Set field-adjustable switches and circuit-breaker trip ranges according to VRF HVAC system manufacturer's written instructions, and as indicated.
- D. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

### 3.11 PROTECTION

- A. Protect products from moisture and water damage. Remove and replace products that are wet, moisture damaged, or mold damaged.
- B. Protect equipment from physical damage. Replace equipment with physical damage that cannot be repaired to new condition. Observable surface imperfections shall be grounds for removal and replacement.
- C. Protect equipment from electrical damage. Replace equipment suffering electrical damage.
- D. Cover and seal openings of equipment to keep inside of equipment clean. Do not remove covers until finish work is complete.

### 3.12 DEMONSTRATION

- A. Engage a VRF HVAC system manufacturer's factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain entire system.
- B. Schedule and Duration:
  - 1. Schedule training with Owner at least 10 business days before first training session.
  - 2. Training shall be held at mutually agreed date and time during normal business hours.
- C. Location: Owner shall provide a suitable on-site location to host classroom training.
- D. Training Materials: Provide training materials in electronic format to each attendee.
  - 1. Include instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
  - 2. Video record each classroom training session and submit an electronic copy to Owner before requesting Owner acceptance of training.
- E. Acceptance: Obtain Owner written acceptance that training is complete, and requirements indicated have been satisfied.

END OF SECTION

## SECTION 238216 - DUCTED HEATING COILS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes duct mounted hydronic heating coils that are not an integral part of air-handling units:

#### 1.2 ACTION SUBMITTALS

- A. Product Data: Include construction details, material descriptions, dimensions rated capacity and pressure drop for each coil.

#### 1.3 QUALITY ASSURANCE

- A. ASHRAE Compliance:
  - 1. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

### PART 2 PRODUCTS

#### 2.1 WATER COILS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Capital Coil & Air. (Basis of Design)
  - 2. [Aerofin Corporation](#).
  - 3. [USA Coil & Air](#).
- B. Performance Ratings: Tested and rated according to ARI 410 and ASHRAE 33.
- C. Minimum Working-Pressure/Temperature Ratings: 200 psig, 325 deg F.
- D. Source Quality Control: Factory tested to 300 psig.
- E. Tubes: ASTM B 743 copper, minimum 0.035 inch thick.
- F. Fins: Aluminum, minimum 0.010 inch thick.
- G. Headers: Seamless copper tube with brazed joints, prime coated.
- H. Frames: Galvanized-steel channel frame, minimum 0.064-inch-thick for flanged mounting.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine ducts, plenums, and casings to receive air coils for compliance with requirements for installation tolerances and other conditions affecting coil performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before coil installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install coils level and plumb.
- B. Install coils in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible." Install duct access doors upstream and downstream of coil for inspection and cleaning.
- C. Straighten bent fins on air coils.
- D. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

### 3.3 CONNECTIONS

- A. Install piping adjacent to coils to allow service and maintenance.
- B. Connect water piping with unions, manual air vents, drain valves and ball valves to allow coils to be disconnected without draining piping.
- C. Install calibrated balance valve on return branch piping and test plugs on supply and return branch piping to accommodate insertion temperature and pressure gauges.
- D. Install two-way control valves with modulating electronic actuators as specified in Section 23 09 00 – Building Automation System.

END OF SECTION



## SECTION 238223 - UNIT VENTILATORS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes unit ventilators and accessories with the following heating and cooling features:
  - 1. Hydronic heating coil.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for each unit type and configuration.
- 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. Plans, elevations, sections, and details.
  - 2. Details of anchorages and attachments to structure and to supported equipment.
  - 3. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes.
- D. Samples for Verification: For each type of unit ventilator

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.
- B. Warranty: Special warranty specified in this Section.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For unit ventilators to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - 1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

#### 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. Unit Ventilator Filters: Furnish one spare filter(s) for each filter installed.

#### 1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- B. Comply with NFPA 70.

#### 1.7 COORDINATION

- A. Coordinate layout and installation of unit ventilators and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

- B. Coordinate size and location of wall sleeves for outdoor-air intake and relief dampers.

#### 1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.

- 1. Warranty Period: Five years from date of Substantial Completion.

### PART 2 PRODUCTS

- 2.1 Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Daikin
  - 2. Magic Aire (Basis of Design)
  - 3. Carrier Corporation

#### 2.2 MANUFACTURED UNITS

- A. Description: Factory-packaged and -tested units rated according to ARI 840, ASHRAE 33, and UL 1995, including finished cabinet, filter, drain pan, supply-air fan, motor, dampers, freezestat and hydronic cooling coil.

## 2.3 CABINETS

- A. Insulation: Minimum 1-inch thick, coated glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
  - 1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
  - 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- B. Drain Pans: Formed as required by ASHRAE 62.1. Drain pan shall be removable.
- C. Cabinet Frame and Access Panels: Welded-steel frame with removable panels fastened with hex-head tamperproof fasteners.
  - 1. Steel components exposed to moisture shall be hot-dip galvanized after fabrication.
- D. Cabinet Finish: Baked enamel, in manufacturer's standard paint color as selected by Architect.
- E. Indoor-Supply-Air Grille: Aluminum, adjustable linear bar.
- F. Return-Air Inlet: Front toe space.
- G. End Panels: Matching material and finish of unit ventilator.
- H. Outdoor-Air Wall Box: Minimum 0.1265-inch-thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen.
  - 1. Louver Configuration: Horizontal rain-resistant louver.
  - 2. Louver Material: Aluminum.
  - 3. Bird Screen: 1/2-inch mesh screen on interior side of louver.
  - 4. Decorative Grille: On outside of intake.
  - 5. Finish: Anodized aluminum, color as selected by Architect from manufacturer's standard colors.

## 2.4 COILS

- A. Test and rate unit ventilator coils according to ASHRAE 33.
- B. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

## 2.5 INDOOR FAN

- A. Fan and Motor Board: Removable.

1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels; and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Fan Shaft and Bearings: Hollow steel shaft with permanently lubricated, resiliently mounted bearings.
3. Motor: Permanently lubricated, multispeed, resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
4. Wiring Termination: Connect motor to chassis wiring with plug connection.

## 2.6 DAMPERS

- A. Mixing Dampers: Galvanized-steel blades with edge and end seals and nylon bearings; with contractor furnished and installed electric actuator.
- B. Face and Bypass Dampers: Galvanized-steel damper blades with edge and end seals and nylon bearings; with contractor furnished and installed electric actuator.
- C. Comply with ASHRAE/IESNA 90.1.

## 2.7 ACCESSORIES

- A. Subbase: Sheet metal floor-mounting base with leveling screws and black enamel finish.
- B. Insulated false back with gasket seals on wall and outdoor-air plenum.
  1. Insulation: Minimum 1-inch thick, coated glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
    - a. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
    - b. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Return-air plenum, 6 inches thick, designed to take return air from top inlet grilles in cabinets on one or both sides of unit ventilator with gasket seals on wall and outdoor-air plenum extension.
- D. Radiation Grille: Aluminum, linear-bar grille with finish to match discharge-air grille.
- E. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
  1. Pleated Cotton-Polyester Media: 90 percent arrestance and 8 MERV.

## 2.8 HYDRONIC PIPING ACCESSORIES

- A. Piping accessories to be furnished and installed by the contractor.
- B. Control Valves: Electric actuators compatible with terminal controller and building controls.
  - 1. Two way, modulating control valve for hot-water heating coil.
- C. Isolation Valves, Strainers, Unions, and Balance Valves:
  - 1. Two-Piece Ball Valves: Bronze body with stainless-steel ball and stem and galvanized-steel lever handle for each supply and return connection. If balancing device is combination shutoff type with memory stop, isolation valve may be omitted on the return.
  - 2. Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and equipped with a memory stop to retain set position.
  - 3. Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A 126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.
  - 4. Wrought-Copper Unions: ASME B16.22.

## 2.9 BASIC UNIT CONTROLS

- A. Control devices and operational sequences are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence of Operations for HVAC Controls."
- B. Freezestat shall be factory installed in unit ventilator. All other control devices including controller, damper actuator, HW valve and actuator to be furnished and installed by contractor.

## 2.10 VERTICAL PIPING ENCLOSURES

- A. Provide vertical piping enclosures at locations indicated on the drawings. Refer to drawings for sizes and configuration.
- B. Basis of Design is Sterling Model PCHV or acceptable equal.
- C. Pipe enclosure shall be 18-gauge metal painted to match adjacent unit ventilator or metal shelving/cabinets.
  - 1. Provide with support angles and jointer strips.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to receive unit ventilators for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit ventilator installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install unit ventilators to comply with NFPA 90A.
- B. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in other mechanical Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
  - 1. Install piping adjacent to machine to allow service and maintenance.
  - 2. Connect piping to unit ventilator with hydronic piping accessories.
  - 3. Connect condensate drain to indirect waste.
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect test, and adjust field-assembled components and equipment installation, including connections and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
  - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

- C. Remove and replace malfunctioning units and retest as specified above.

### 3.5 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

### 3.6 DEMONSTRATION

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

END OF SECTION 238223

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## SECTION 238236 - FINNED-TUBE RADIATION HEATERS

### 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 hydronic finned-tube radiation heaters.

#### 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and details.
  - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include details and dimensions of custom-fabricated enclosures.
  - 4. Indicate location and size of each field connection.
  - 5. Indicate location and arrangement of piping valves and specialties.
  - 6. Indicate location and arrangement of integral controls.
  - 7. Include enclosure joints, corner pieces, access doors, and other accessories.
  - 8. Include diagrams for power, signal, and control wiring.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Color Samples for Initial Selection: For finned-tube radiation heaters with factory-applied color finishes.
- E. Color Samples for Verification: For each type of exposed finish.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Structural members, including wall construction, to which finned-tube radiation heaters will be attached.
  2. Method of attaching finned-tube radiation heaters to building structure.
  3. Penetrations of fire-rated wall and floor assemblies.
- B. Field quality-control reports.

## PART 2 PRODUCTS

### 2.1 HOT-WATER FINNED-TUBE RADIATION HEATERS

- A. Performance Ratings: Rate finned-tube radiation heaters according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."
- B. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports. One end of tube shall be belled.
- C. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.
- D. Rust-Resistant Front Panel: Minimum 0.064-inch-thick, ASTM A 653/A 653M, G60 galvanized steel.
- E. Wall-Mounted Back Panel: Minimum 0.0329-inch-thick steel, full height, with full-length channel support for front panel without exposed fasteners.
- F. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.
- G. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.
- H. Damper: Knob-operated internal damper at enclosure outlet.
- I. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.
- J. Enclosure Style: Flat top.
  1. Top Outlet Grille: Punched louver; painted to match enclosure.
- K. Accessories: Filler sections, corners, relay sections, and splice plates all matching the enclosure and grille finishes.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to receive finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for hydronic-piping connections to verify actual locations before installation of finned-tube radiation heaters.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 FINNED-TUBE RADIATION HEATER INSTALLATION

- A. Install units level and plumb.
- B. Install enclosure continuously around corners, using outside and inside corner fittings.
- C. Join sections with splice plates and filler pieces to provide continuous enclosure.
- D. Install access doors for access to valves.
- E. Install enclosure continuously from wall to wall.
- F. Terminate enclosures with manufacturer's end caps except where enclosures are indicated to extend to adjoining walls.
- G. Install valves within reach of access door provided in enclosure.
- H. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.
- I. Install piping within pedestals for freestanding units.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in Section 232113 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect hot-water finned-tube radiation heaters and components to piping according to Section 232113 "Hydronic Piping".
  - 1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.
- C. Install control valves as required by Section 230923.11 "Control Valves."
- D. Install piping adjacent to finned-tube radiation heaters to allow service and maintenance.

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following field 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 operation.
  3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION

## SECTION 238241 - UNIT HEATERS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Perform all Work required to provide and install unit heaters indicated by the Contract Documents with supplementary items necessary for proper installation.

#### 1.2 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
  - 1. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
  - 2. Location and arrangement of piping, valves and specialties.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For unit heaters to include in emergency, operation, and maintenance manuals.

#### 1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum twenty (20) years documented experience.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

#### 1.5 REFERENCE STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
  - 1. ASHRAE Standard 33 - Methods of Testing Forced Circulation Air Cooling and Air Heating Coils

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Subject to compliance with requirements, provide product indicated on Drawings or approved equal.

### 2.2 HOUSINGS

- A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested unit heaters before shipping.
- B. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

### 2.3 COILS

- A. General Coil Requirements: Test and rate hot-water 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.
- C. 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.

### 2.4 FAN AND MOTOR

- A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- B. Motor: Permanently lubricated, multispeed.

### 2.5 CONTROLS

- A. Control Devices:
  - 1. Low voltage thermostat.

### 2.6 ELECTRICAL

- A. Disconnect Switch: Unit shall be furnished with a factory furnished and field installed, non-fused disconnect switch. The switch shall ship loose for mounting and wiring by the Electrical Contractor.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

- A. Install unit heaters level and plumb.
- B. Suspend unit heaters from structure with all-thread hanger rods and elastomeric hangers.

#### 3.2 CONNECTIONS

- A. Install unit and piping to allow service and maintenance.
- B. Comply with safety requirements in UL 1995.
- C. Unless otherwise indicated, install ball valve on supply water connection and ball valve, calibrated balancing valve and control valve on return water connection of unit heater.

END OF SECTION 238241

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## SECTION 260500 - GENERAL ELECTRICAL REQUIREMENTS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. The General and Supplementary Conditions are a part of the requirements for the work under this Division of the Specifications.

#### 1.2 WORK INCLUDED

- A. Provide labor and materials required to install, test and place into operation the electrical systems as called for in the Contract Documents, and in accordance with applicable codes and regulations.
- B. Provide labor, materials, and accessories required to provide complete, operating electrical systems. Labor, materials or accessories not specifically called for in the Contract Documents, but required to provide complete, operating electrical systems shall be provided without additional cost to the Owner.

#### 1.3 QUALITY ASSURANCE

- A. Comply with the current applicable codes, ordinances, and regulations of the Authority or Authorities Having Jurisdiction, the rules, regulations and requirements of the utility companies serving the project, and the Owner's insurance underwriter.
- B. Drawings, specifications, codes and standards are minimum requirements. Where requirements differ, the most stringent apply.
- C. Should any change in drawings or specifications be required to comply with governing regulations, notify the Engineer prior to submitting bid.
- D. All electrical equipment, materials, devices and installations shall meet or exceed minimum requirements of ADA, ANSI, ASTM, IEEE, IES, NEC, NEMA, NETA, NFPA, OSHA, SMACNA, UL, and the State Fire Marshal.
- E. Execute work in strict accordance with the best practices of the trades in a thorough, substantial, workperson-like manner by competent workpeople. Provide a competent, experienced, full-time Superintendent who is authorized to make decisions on behalf of the Contractor.
- F. Equipment shall be certified for use in the state of New York and shall meet the New York State energy code.

## 1.4 ABBREVIATIONS AND DEFINITIONS

### A. Abbreviations:

1. Americans with Disabilities Act
2. American National Standards Institute
3. Acoustical Society of America
4. American Society for Testing and Materials
5. Basic Impulse Level
6. Certified Ballast Manufacturers
7. Engineer's Control Center
8. Electronic Industries Alliance
9. Electrical Testing Laboratories, Inc.
10. Fire Control Center
11. Factory Mutual
12. Institute of Electrical and Electronic Engineers
13. Illuminating Engineering Society
14. International Power Cable Engineers Association
15. Light Emitting Diode
16. National Electric Code
17. National Electrical Manufacturers Association
18. National Electrical Testing Association
19. National Fire Protection Association
20. Original Equipment Manufacturer
21. Occupational Safety and Health Administration
22. Security Control Center
23. Sheet Metal and Air Conditioning Contractors  
National Association
24. Telecommunications Industry Association
25. Underwriters Laboratories Inc.

### B. Definitions:

1. Where it is stated in these specifications to submit to Engineer for review, refer to Architectural General and Supplementary Conditions for proper procedures.
2. FURNISH means to supply all materials, labor, equipment, testing apparatus, controls, tests, accessories and all other items customarily required for the proper and complete application.
3. INSTALL means to join, unite, fasten, link, attach, set up or otherwise connect together before testing and turning over to Owner, complete and ready for regular operation.
4. PROVIDE means to FURNISH and INSTALL.
5. AS DIRECTED means as directed by the Engineer, or the Engineer's Representative.

6. CONCEALED means embedded in masonry or other construction, installed behind wall furring or within drywall partitions, or installed within hung ceilings.
7. SUBMIT means submit to Engineer for review.

## 1.5 GUARANTEE

- A. Submit a single guarantee stating that the work is in accordance with the Contract Documents. Guarantee work against faulty and improper material and workmanship for a period of one year from the date of final acceptance by the Owner, except that where guarantees or warranties for longer terms are provided or specified herein, the longer term shall apply. Manufacturer's warranty/guarantee on equipment shall be begin at time of equipment startup not upon receipt of equipment. Correct any deficiencies, which occur during the guarantee period, within 24 hours of notification, without additional cost to the Owner, to the satisfaction of the Owner. Obtain similar guarantees from subcontractors, manufacturers, suppliers and subtrade specialists.

## 1.6 USE OF THE ARCHITECT'S AND ENGINEER'S DRAWINGS

- A. The Contractor shall obtain, at the Contractor's expense, from the Architect or Engineer a set of AutoCAD or compatible format architectural and engineering drawings on electronic media where desired by the Contractor and/or required by the Specifications for use in preparing the shop drawings, coordination drawings, and record drawings. The Contractor shall provide to the Architect and Engineer a written release of liability acceptable to the Architect and Engineer prior to receiving the electronic media.

## PART 2 PRODUCTS

### 2.1 EQUIPMENT AND MATERIALS

- A. Provide products and materials that are new, clean, free of defects, and free of damage and corrosion.
- B. Products and materials shall not contain asbestos, PCB, or any other material that is considered hazardous by the Environmental Protection Agency or any other Authority Having Jurisdiction.
- C. Replace materials of less than specified quality and relocate work incorrectly installed as directed by the Architect or Engineer at no additional cost to the Owner.
- D. Provide name/data plates on major components of equipment with manufacturer's name, model number, serial number, capacity data and electrical characteristics attached in a conspicuous place.
- E. Install materials and equipment with qualified trades people.

- F. Maintain uniformity of manufacturer for equipment used in similar applications and sizes.
- G. Fully lubricate equipment where required.
- H. Follow manufacturer's instructions for installing, connecting, and adjusting equipment. Provide a copy of such instructions at the equipment during installation.
- I. Where factory testing of equipment is required to ascertain performance, and attendance by the Owner's Representative is required to witness such tests, associated travel costs and subsistence shall be paid for by the Contractor.
- J. Equipment capacities, ratings, etc., are scheduled or specified for job site operating conditions. Equipment sensitive to altitude shall be derated with the method of derating identified on the submittals.
- K. Enclosures for electrical equipment installed in mechanical and electrical equipment rooms shall be NEMA type 1 gasketed. Enclosures for electrical equipment installed outdoors shall be NEMA type 3R.
- L. Energy consuming equipment shall be certified for use in the state of New York and shall meet the New York State Energy Code and local energy ordinances.

## 2.2 SUBSTITUTIONS

- A. Contract Documents are based on equipment manufacturers as called out in the Specifications and indicated on the Drawings. Acceptance of substitute equipment manufacturers does not relieve Contractor of the responsibility to provide equipment and materials, which meet the performance as, stated or implied in the Contract Documents.
- B. Submit proposals to provide substitute materials or equipment, in writing, with sufficient lead time for review prior to the date equipment must be ordered to maintain project schedule. Reimburse Owner for costs associated with the review of the proposed substitution whether substitution is accepted or rejected.
- C. Indicate revisions required to adapt substitutions including revisions by other trades. Substitutions that increase the cost of the work and related trades are not permitted.
- D. The proposed substitution shall conform to the size, ratings, and operating characteristics of the equipment or systems as specified and shown on the Drawings.
- E. Proposals for substitutions shall include the following information:

1. A description of the difference between the Contract Document requirements and that of the substitution, the comparative features of each, and the effect of the change on the end result performance. Include the impact of all changes on other contractors and acknowledge the inclusion of additional costs to the other trades.
2. Schematic drawings and details.
3. List of revisions to the Contract Documents that must be made if the substitution is accepted.
4. Estimate of costs the Owner may incur in implementing the substitution, such as test, evaluation, operating and support costs.
5. Statement of the time by which a Contract modification accepting the substitution must be issued, noting any effect on the Contract completion time or the delivery schedule.
6. A statement indicating the reduction to the Contract price if the Owner accepts the substitution. Include required modifications to all related trades.

## PART 3 EXECUTION

### 3.1 FEES AND PERMITS

- A. Pay all required fees and obtain all required permits related to the electrical installation.
- B. Pay royalties or fees in connection with the use of patented devices and systems.
- C. Provide controlled inspection where required by Authorities Having Jurisdiction or by these specifications.

### 3.2 SUBMITTALS AND REVIEWS

- A. Submit shop drawings, manufacturer's product data sheets, samples, and test reports as specified.
- B. After execution of Owner/Contractor Agreement, submit a complete typed list of all electrical equipment manufacturers and material suppliers for the equipment proposed to be provided on this project, as well as names of all subcontractors.
- C. After execution of Owner/Contractor Agreement, prepare an index of all submittals for the project. Include a submittal identification number, a cross-reference to the Specification sections or Drawing number, and an item description. Prefix the submittal identification number by the Specification sections to which they apply. Indicate on each submittal, the submittal identification number in addition to the other data specified. All subcontractors shall utilize the assigned submittal identification number.

- D. After the Contract is awarded, obtain complete shop drawings, product data and samples from the manufacturers, suppliers, vendors, and all subcontractors, for all materials and equipment as specified. Submit data and details of such materials and equipment for review. Prior to submission, certify that the shop drawings, product data and samples are in compliance with the Contract Documents. Check all materials and equipment upon their arrival on the job site and verify their compliance with the Contract Documents. Modify any work, which proceeds prior to receiving accepted shop drawings as required to comply with the Contract Documents and the shop drawings.
- E. Review of submittals is for general compliance with the design concept and Contract Documents. Comments or absence of comments shall not relieve the Contractor from compliance with the Contract Documents. The Contractor remains solely responsible for details and accuracy, for confirming and correlating all quantities and dimensions, for selecting fabrication processes, for techniques of construction, for performing the work in a safe manner, and for coordinating the work with that of other trades.
- F. No part of the work shall be started in the shop or in the field until the shop drawings and samples for that portion of the work have been submitted and accepted.
- G. A minimum period of ten working days, exclusive of transmittal time, will be required in the Engineer's office each time a shop drawing, product data and/or samples are submitted for review. This time period must be considered by the Contractor in the scheduling of the work.
- H. Submit electronic copies, preferably in PDF format, of all items requiring shop drawings.
- I. Submit materials and equipment by manufacturer, trade name, and model number. Include copies of applicable brochure or catalog material. Maintenance and operating manuals are not acceptable substitutes for shop drawings.
- J. Identify each sheet of printed submittal pages (using arrows, underlining or circling) to show applicable sizes, types, model numbers, ratings, capacities and options actually being proposed. Cross out non-applicable information. Note specified features such as materials or paint finishes.
- K. Include dimensional data for roughing in and installation and technical data sufficient to verify that equipment meets the requirements of the Contract Documents. Include wiring, piping and service connection data.
- L. Maintain a complete set of reviewed and stamped shop drawings and product data on site.
- M. For each room or area of the building containing electrical equipment, submit the following:

1. Floor Plans: Plan and elevation layout drawings indicating the equipment in the exact location in which it is intended to be installed. These plans shall be of a scale not less than 1/4 inch to 1 foot. They shall be prepared in the following manner:
    - a. Indicate the physical boundaries of the space including door swings and ceiling heights and ceiling types (as applicable).
    - b. Illustrate all electrical equipment proposed to be contained therein. Include top and bottom elevations of all electrical equipment. The Drawings shall be prepared utilizing the dimensions contained in the individual equipment submittals. Indicate code and manufacturer's required clearances.
    - c. Illustrate all other equipment therein such as conduits, detectors, luminaries, ducts, registers, pull boxes, wireways, structural elements, etc.
    - d. Indicate the operating weight of each piece of equipment.
    - e. Indicate the heat release from each piece of electrical equipment in terms of BTU per hour. This information shall be that which is supplied by the respective manufacturers.
    - f. Illustrate concrete pads, curbs, etc.
    - g. Indicate dimensions to confirm compliance with code-required clearances.
    - h. Indicate maximum normal allowable operating temperature for each piece of equipment (as per each respective manufacturer's recommendation).
    - i. Equipment removal routes.
  - N. The work described in shop drawing submissions shall be carefully checked by all trades for clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and coordination with other trades on the job. Each submitted shop drawing shall include a certification that related job conditions have been checked by the Contractor and each Subcontractor and that conflicts do not exist.
  - O. The Contractor is not relieved of the responsibility for dimensions or errors that may be contained on submissions, or for deviations from the requirements of the Contract Documents. The noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the shop drawings, product data and samples, the Contract Documents govern the work and are neither waived nor superceded in any way by the review of shop drawings, product data and samples.
  - P. Inadequate or incomplete shop drawings, product data and/or samples will not be reviewed and will be returned to the Contractor for resubmittal.
- ### 3.3 COORDINATION OF WORK
- A. The Contract Documents establish scope, materials and quality but are not detailed installation instructions. Drawings are diagrammatic.

- B. Coordinate work with related trades and furnish, in writing, any information necessary to permit the work of related trades to be installed satisfactorily and with the least possible conflict or delay.
- C. The electrical drawings show the general arrangement of equipment and appurtenances. Follow these drawings as closely as the actual construction and the work of other trades will permit. Provide offsets, fittings, and accessories, which may be required but not shown on the Drawings. Investigate the site, and review drawings of other trades to determine conditions affecting the work, and provide such work and accessories as may be required to accommodate such conditions.
- D. The locations of lighting fixtures, outlets, panels and other equipment indicated on the Drawings are approximately correct, but they are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed in consequence of increase or reduction of the number of outlets, or in order to meet field conditions, or to coordinate with modular requirements of ceilings, or to simplify the work, or for other legitimate causes.
- E. Exercise particular caution with reference to the location of panels, outlets, switches, etc., and have precise and definite locations accepted by the Engineer before proceeding with the installation.
- F. The Drawings show only the general run of raceways and approximate locations of outlets. Any significant changes in location of outlets, cabinets, etc., necessary in order to meet field conditions shall be brought to the immediate attention of the Engineer for review before such alterations are made. Modifications shall be made at no additional cost to the Owner.
- G. Verify with the Architect the exact location and mounting height of outlets and equipment not dimensionally located on the Drawings prior to installation.
- H. Circuit tags in the form of numbers are used where shown to indicate the circuit designation numbers in electrical panels. Show the actual circuit numbers on the as-built Record Drawings and on the associated typed panelboard directory card. Where circuiting is not indicated, provide required circuiting in accordance with the loading indicated on the Drawings and/or as directed.
- I. The Drawings generally do not indicate the number of wires in conduit for the branch circuit wiring of fixtures and outlets, or the actual circuiting. Provide the correct wire size and quantity as required by the indicated circuiting and/or circuit numbers indicated, the control intent, referenced wiring diagrams (if any), the specified voltage drop or maximum distance limitations, and the applicable requirements of the NEC.
- J. Carefully check space requirements with other trades to ensure that equipment can be installed in the spaces allotted.



- K. Wherever work interconnects with work of other trades, coordinate with other trades to ensure that they have the information necessary so that they may properly install the necessary connections and equipment. Identify items (remote ballast, pull boxes, etc.) requiring access in order that the ceiling trade will know where to install access doors and panels.
- L. Consult with other trades regarding equipment so that, wherever possible, motor controls and distribution equipment are of the same manufacturer.
- M. Furnish and set sleeves for passage of electrical risers through structural masonry and concrete walls and floors and elsewhere as required for the proper protection of each electrical riser passing through building surfaces.
- N. Provide firestopping around all pipes, conduits, ducts, sleeves, etc. which pass through rated walls, partitions and floors.
- O. Provide detailed information on openings and holes required in precast members for electrical work.
- P. Provide required supports and hangers for conduit and equipment, designed so as not to exceed allowable loadings of structures.
- Q. Examine and compare the Contract Documents with the drawings and specifications of other trades, and report any discrepancies between them to the Engineer and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before installation, make proper provisions to avoid interferences.
- R. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the Drawings as to the area to which it applies. Submit these drawings to the Engineer for review. At completion include a set of these drawings with each set of Record Drawings.
- S. Furnish services of an experienced Superintendent, who shall be in constant charge of all work, and who shall coordinate work with the work of other trades. No work shall be installed before coordinating with other trades.
- T. Coordinate with the local electric utility company and the local telecommunications company as to their requirements for service connections and provide all necessary metering provisions, grounding, materials, equipment, labor, testing, and appurtenances.
- U. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions, which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.

- V. Adjust location of conduits, panels, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.
  - 1. Right-of-Way: Lines which pitch have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
  - 2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.
- W. In cases of doubt as to the work intended, or in the event of need for explanation, request supplementary instructions from the Engineer.

### 3.4 CONTRACTOR'S COORDINATION DRAWINGS

- A. The Contractor shall coordinate efforts of all trades and shall furnish (in writing, with copies to the Engineer) any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.
- B. The Contractor and all trade contractors shall prepare a complete set of construction Coordination Drawings indicating the equipment actually purchased and the exact routing for all lines such as busway, conduit, piping, ductwork, etc., including conduit embedded in concrete floors and walls. The Coordination Drawings shall be submitted complete to the Architect and the Engineer, within three months after notice to proceed is given, and in compliance with the construction schedule for the project. The sheet metal drawings, at a scale of not less than 1/4 inch to 1 foot, shall serve as the base drawings to which all other Contractors shall add their work. Each separate trade contractor shall draw their work on separate layers with different color assignments to facilitate coordination. Each Coordination Drawing shall be completed and signed off by the other Trade Contractors and the Contractor prior to the installation of the HVAC, plumbing, electrical and fire sprinkler work in the area covered by the specific drawing. The Contractor's work shall be installed according to the shop drawings and coordination drawings. If the Contractor allows one trade to install their work before coordination with the work of other trades, the Contractor shall make all necessary changes to correct the condition at no additional cost to the Owner.

- C. The Contractors' Coordination Drawings shall indicate structural loads at support points for all piping 10 inch and larger, racked piping, racked conduit, busway, and suspended electrical equipment. Submit to Structural Engineer for review and approval. The elevation, location, support points, static, dynamic and expansion forces and loads imposed on the structure at support and anchor points shall be indicated. All beam penetrations and slab penetrations shall be indicated and sized and shall be coordinated. Work routed underground or embedded in concrete shall be indicated by dimension to column and building lines and shall be coordinated. Coordination Drawings shall document all required structural penetrations for initial construction. Penetrations shall be dimensioned for walls, floors and roofs. These structural coordination requirements require review and approval by the Structural Engineer prior to completion and submittal of the Drawings.
- D. This requirement for Coordination Drawings shall not be construed as authorization for the Contractor or trade contractors to make any unauthorized changes to the Contract Documents. Contract document space allocations shall be maintained such as ceiling height, designated clearance for future construction and flexibility, chase walls, equipment room size, unless prior written authorization is received from the Engineer to change them.
- E. Prior to final acceptance of the Work, the Contractor shall submit the Coordination Drawings as part of the Record Drawings submittal.

### 3.5 EXAMINATION OF SITE

- A. Prior to the submitting of bids, visit the project site and become familiar with all conditions affecting the proposed installation and make provisions as to the cost thereof.
- B. The Contract Documents do not make representations regarding the character or extent of the sub-soils, water levels, existing structural, mechanical and electrical installations, above or below ground, or other sub-surface conditions which may be encountered during the work. Evaluate existing conditions, which may affect methods or cost of performing the work, based on examination of the site or other information. Failure to examine the Drawings or other information does not relieve the Contractor of responsibility for the satisfactory completion of the work.

### 3.6 EXCAVATION AND BACKFILL

- A. Provide excavation for the work of this Division. Excavate all material encountered, to the depths indicated on the Drawings or as required. Remove from the site excavated materials not required or suitable for backfill. Provide grading as may be necessary to prevent surface water from flowing into trenches or other excavations. Remove any water, which accumulates. Provide sheeting and shoring as may be necessary for the protection of the work and for the safety of personnel.
- B. Provide trenches of widths necessary for the proper execution of the work. Grade bottom of the trenches accurately to provide uniform bearing and support the work on undisturbed soil at every point along its entire length. Except where rock is encountered, do not excavate below the depths indicated. Where rock excavations are required, excavate rock to a minimum overdepth of four inches below the trench depths indicated on the Drawings or required. Backfill overdepths in the rock excavation and unauthorized overdepths with loose, granular, moist earth, thoroughly machine-tamped to a compaction level of at least 95 percent to standard proctor density or 75 percent relative density or as specified by the Engineer. Whenever unstable soil that is incapable of properly supporting the work is encountered in the bottom of the trench, remove soil to a depth required and backfill the trench to the proper grade with coarse sand, fine gravel or other suitable material.
- C. Excavate trenches for utilities that will provide the following minimum depths of cover from existing grade or from indicated finished grade, whichever is lower, unless otherwise specifically shown:
  - 1. Electric service: Three (3) feet minimum.
  - 2. Telephone service: Three (3) feet minimum.
  - 3. Cable TV service: Three (3) feet minimum
- D. Trenches should not be placed within ten feet of foundation or soil surfaces, which must resist horizontal forces.
- E. Do not backfill trenches until all required tests have been performed and installation observed by the Engineer. Comply with the requirements of other sections of the Specifications. Backfill shall consist of non-expensive soil with limited porosity. Deposit in six layers and thoroughly and carefully tamp until the work has a cover of not less than one foot. Backfill and tamp remainder of trench at one-foot intervals until complete. Uniformly grade the finished surface.

### 3.7 CUTTING AND PATCHING

- A. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, lay out the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, metalwork, etc., using skilled tradespeople of the trades required at no additional cost to the Owner.

- B. Do not cut, channel, chase or drill unfinished masonry, tile, etc., unless permission from the Architect is obtained. If permission is granted, perform this work in a manner acceptable to the Architect.
- C. Where conduit or equipment are mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.
- D. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Owner.

### 3.8 MOUNTING HEIGHTS

- A. Mounting heights shall conform to ADA requirements.
- B. Verify exact locations and mounting heights with the Architect before installation.
- C. Electrical and telecommunications outlets shall be mounted no higher than 48 inches above finished floor to top of the outlet box and no lower than 15 inches above finished floor to bottom of the outlet box.
- D. Electrical switches shall be mounted no higher than 48 inches above finished floor to top of the outlet box and no lower than 36 inches above finished floor to bottom of the outlet box.
- E. Fire alarm manual pull stations shall be mounted no higher than 48 inches above finished floor to top of the outlet box and no lower than 36 inches above finished floor to bottom of the outlet box.
- F. Outlets for public and other wall-mounted type telephones shall be installed so that the particular telephone installed conforms to ADA mounting height requirements.
- G. Visual Alarms: Mount not less than 80 inches to the bottom or 96 inches to the top of the device.
- H. Wall-Mounted Exit Signs: Two inches above top of door to bottom of sign.
- I. Low-Level Exit Signs: Six inches to bottom of sign.
- J. Stairwell and utility corridor wall-mounted lighting fixtures shall be mounted 8 feet-6 inches above finished floor or one foot below ceiling or structure above, whichever is lower.

### 3.9 CLEANING UP

- A. Avoid accumulation of debris, boxes, loose materials, crates, etc., resulting from the installation of this work. Remove from the premises each day all debris, boxes, etc., and keep the premises clean and free of dust and debris.
- B. Clean all fixtures and equipment at the completion of the project. Wipe clean exposed lighting fixture reflectors and trim pieces with a non-abrasive cloth just prior to occupancy.
- C. All electrical equipment shall be thoroughly vacuumed and wiped clean prior to energization and at the completion of the project. Equipment shall be opened for observation by the Engineer as required.

### 3.10 WATERPROOFING

- A. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.
- B. Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the Owner.

### 3.11 SUPPORTS

- A. Support work in accordance with the best industry practice. Provide supports, hangers, auxiliary structural members and supplemental hardware required for support of the work.
- B. Provide supporting frames or racks extending from floor slab to ceiling slab for work indicated as being supported from walls where the walls are incapable of supporting the weight. In particular, provide such frames or racks in electric closets and mechanical equipment rooms.
- C. Provide supporting frames or racks for equipment which is to be installed in a freestanding position.
- D. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members, rigidly bolted or welded together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of all equipment mounted on them.
- E. Adequate support of equipment (including outlet, pull and junction boxes and fittings) shall not depend on electric conduits, raceways, or cables for support.

- F. Electrical equipment shall not rest on or depend for support on suspended ceiling media (tiles, lath, plaster, as well as splines, runners, bars and the like in the plane of the ceiling). Provide independent support of electrical equipment. Do not attach to supports provided for ductwork, piping or work of other trades.
- G. Provide required supports and hangers for conduit, equipment, etc., so that loading will not exceed allowable loadings of structure. Electrical equipment and supports shall not come in contact with work of other trades.

### 3.12 FASTENINGS

- A. Fasten equipment to building structure in accordance with the best industry practice.
- B. Where weight applied to building attachment points is 100 pounds or less, conform to the following as a minimum:
  - 1. Wood: Wood screws.
  - 2. Concrete and solid masonry: Bolts and expansion shields.
  - 3. Hollow construction: Toggle bolts.
  - 4. Solid metal: Machine screws in tapped holes or with welded studs.
  - 5. Steel decking or sub-floor: Fastenings as specified below for applied weights in excess of 100 pounds.
- C. Where weight applied to building attachment points exceeds 100 pounds, but is 300 pounds or less, conform to the following as a minimum:
  - 1. At concrete slabs provide 24-inch by 24-inch by 1/2-inch steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top of slab screed line, where no fill is to be applied.
  - 2. At steel decking or sub-floor for all fastenings, provide through bolts or threaded rods. The tops of bolts or rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with their decking or sub-floor, such hangers shall be provided.
- D. Where weight applied to building attachment points exceeds 300 pounds, coordinate with and obtain the approval of Engineer and conform to the following as a minimum:
  - 1. Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
- E. For items, which are shown, as being ceiling-mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.

- F. Wall-mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars. Prefabricated steel channels as manufactured by Kindorf or Unistrut are acceptable.

### 3.13 IDENTIFICATION

- A. Identify electrical equipment with permanently attached black phenolic nameplates with 1/2-inch high white engraved lettering. Identification shall include equipment name or load served as appropriate. Nameplates for equipment connected to the emergency power system shall be red with white lettering. Nameplates shall be attached with cadmium-plated screws; peel-and-stick tape or glue-on type nameplates are not allowed.
- B. Cable tags shall be flameproof secured with flameproof non-metallic cord.
- C. Provide an engraved nameplate for each switch controlling loads, which are not local to the switch.
- D. Wherever raceways for future use are terminated outside of the building, stake the location with a 2-foot long, 1-inch by 1-inch clear heart redwood stake.
- E. See individual Sections for additional identification requirements.

### 3.14 PROHIBITED LABELS AND IDENTIFICATIONS

- A. In all public areas, the inclusion or installation of any equipment or assembly which bears on any exposed surface any name, trademark, or other insignia which is intended to identify the manufacturer, the vendor, or other source(s) from which such object has been obtained, is prohibited, unless otherwise approved by Owner.
- B. Required UL labels shall not be removed nor shall identification specifically required under the various technical sections of the Specifications be removed.

### 3.15 EQUIPMENT PADS AND ANCHOR BOLTS

- A. Provide concrete pads under all floor-mounted electrical equipment. Equipment pads shall conform to the shape of the piece of equipment it serves with a minimum 1-inch margin around the equipment and supports. Pads shall be a minimum of 4 inches high and made of a minimum 28 day, 2500 psi concrete reinforced with 6-inch by 6-inch 6/6 gauge welded wire mesh. Trowel tops and sides of pad to smooth finishes, equal to those of the floors, with all external corners bullnosed to a 3/4-inch radius.



- B. Provide galvanized anchor bolts for all equipment placed on concrete equipment pads, inertia blocks, or on concrete slabs. Provide bolts of the size and number recommended by the manufacturer of the equipment and locate by means of suitable templates. Equipment installed on vibration isolators shall be secured to the isolator. Secure the isolator to the floor, pad, or support as recommended by the vibration isolation manufacturer.
- C. Where equipment is mounted on gypsum board partitions, the mounting screws shall pass through the gypsum board and securely attach to the partition studs. As an alternative, the mounting screws may pass through the gypsum board and be securely attached to 6 inches square, 18 gauge galvanized metal backplates, which are attached to the gypsum board with an approved non-flammable adhesive. Toggle bolts installed in gypsum board partitions are not allowed.

### 3.16 DELIVERY, DRAYAGE, AND HAULING

- A. Provide drayage, hauling, hoisting, shoring and placement in the building of equipment specified and be responsible for the timely delivery and installation of equipment as required by the construction schedule. If any item of equipment is received prior to the time that it is required, the Contractor shall be responsible for its proper storage and protection until the time it is required. Pay for all costs of drayage or storage.
- B. If equipment is not delivered or installed at the project site in a timely manner as required by the project construction schedule, the Contractor shall be responsible for resulting disassembly, re-assembly, manufacturer's supervision, shoring, general construction modification, delays, overtime costs, etc., at no additional cost to the Owner.

### 3.17 EQUIPMENT AND MATERIALS PROTECTION

- A. Protect the work, equipment, and material of other trades from damage by work or workmen of this trade, and correct damaged caused without additional cost to the Owner.
- B. Take responsibility for work, materials, and equipment until finally inspected, tested and accepted. Protect work against theft, injury, or damage, and carefully store material and equipment received on site, which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing material. Cover and protect equipment and materials from damage due to water, spray-on fireproofing, construction debris, etc. Store equipment to moisture damage in dry, heated spaces.

- C. Provided adequate means for fully protecting finished parts of materials and equipment against damage from whatever cause during the progress of the work until final acceptance. Protect materials and equipment in storage and during construction in such a manner that no finished surfaces will be damaged or marred, and moving parts are kept clean and dry. Do not install damaged items; take immediate steps to obtain replacement or repair.

### 3.18 TESTING OF ELECTRICAL SYSTEMS

- A. Comply with the project construction schedule for the date of final performance and acceptance testing, and complete work sufficiently in advance of the Contract completion date to permit the execution of the testing prior to occupancy and Contract close-out. Complete any adjustments and/or alterations, which the final acceptance tests indicate as necessary for the proper functioning of all equipment prior to the completion date. See individual Sections for extent of testing required.
- B. Provide a detailed schedule of completion indicating when each system is to be completed and outlining when field testing will be performed. Submit completion schedule for review within six months after the notice to proceed by Owner's Representative has been given. Update this schedule periodically as the project progresses.

### 3.19 OPERATING INSTRUCTIONS

- A. Provide the services of factory-trained specialists to provide an operating instructions seminar for equipment and systems. The seminar shall be conducted over a five-day (consecutive) period. Instruction time is defined as straight time working hours and does not include nights, weekends, or travel time to and from the project.
- B. Submit seminar agenda, schedule and list of representatives to the Owner for approval 30 days prior to suggested date of seminar. Do not commence seminar until the Owner has issued a written acceptance of the starting time and attendees. Confirm attendance of seminar by written notification to participants.
- C. Instruct Owner's operating personnel in proper starting sequences, operation, shut-down, general maintenance and preventative maintenance procedures, including normal and emergency procedures.
- D. Submit final copies of Record Drawings and Operating and Maintenance Manuals to Owner at seminar.
- E. Submit a written record of minutes and attendees of the seminar to the Owner.

### 3.20 OPERATING AND MAINTENANCE MANUALS

- A. Provide Operating and Maintenance Manuals for equipment and materials furnished under this Division.
- B. Submit three final copies of Operating and Maintenance Manuals for review at least ten weeks before the completion date. Assemble data in a completely indexed volume or volumes in three-ring binders and identify the size, model, and features indicated for each item. Print the project name on the outside of the binders.
- C. Maintenance manuals shall include complete cleaning and servicing data compiled in a clear and easily understandable format. Show model numbers of each piece of equipment, complete lists of replacement parts, capacity ratings, and actual loads.
- D. Provide the following information where applicable:
  - 1. Identifying name and mark number
  - 2. Locations (where several similar items are used, provide a list)
  - 3. Complete nameplate data
  - 4. Certified Record Drawings and Final Reviewed submittals
  - 5. Parts list
  - 6. Performance curves and data
  - 7. Wiring diagrams
  - 8. Manufacturer's recommended operating and maintenance instructions with all non-applicable information deleted
  - 9. List of spare parts recommended for normal service requirements
  - 10. Assembly and disassembly instructions with exploded-view drawings where necessary
  - 11. Test reports
  - 12. Trouble shooting diagnostic instructions, where applicable

### 3.21 RECORD DRAWINGS

- A. The Contractor shall maintain on a daily basis at the Project site a complete set of Record Drawings. The Record Drawings shall initially consist of a set of construction drawings or AutoCAD files of the Contractor's Coordination Drawings. The prints shall be marked or the AutoCAD files electronically updated to show the precise location of all buried or concealed work and equipment, including embedded conduit, raceways and boxes, and all changes and deviations in the Electrical work from that shown on the Contract Documents. This requirement shall not be construed as authorization for the Contractor to make changes in the layout or work without definite written instructions from the Architect or Engineer. The updated Coordination Drawings shall be used to produce the final Record Drawings that shall be delivered to the Owner in AutoCAD electronic format and full-size hard copy format upon Project completion.
- B. Record dimensions clearly and accurately to delineate the work as installed. Suitably identify locations of all equipment by at least two dimensions to permanent structures.

- C. The Contractor and Subcontractor shall mark all in-progress Record Drawings on the front lower right hand corner with a rubber stamp impression or an AutoCAD image similar to the following:

RECORD DRAWING  
(3/8-inch high letters)

To be used for recording Field Deviations and Dimensional Data Only  
(5/16-inch high letters)

- D. Upon completion of the work, the Contractor and Subcontractor(s) shall certify all Record Drawings on the front lower right hand corner adjacent to the above marking with a rubber stamp impression or an AutoCAD image similar to the following:

RECORD DRAWING  
CERTIFIED CORRECT  
(3/8-inch high letters)

(Printed Name of General Contractor)  
(5/16-inch high letters)  
Date:

(Printed Name of Subcontractor)  
(5/16-inch high letters)  
Date:

- E. Prior to final acceptance of the Work of this Division, the Contractor shall submit properly certified Record Drawings to the Architect and Engineer for review and shall make changes, corrections, or additions as the Architect and/or Engineer may require to the Record Drawings. After the Architect's and Engineer's review, and any required Contractor revisions, the Record Drawings shall be delivered to the Owner on electronic media in AutoCAD format. The Architect and Engineer do not assume any responsibility for the accuracy or completeness of the Record Drawings.

### 3.22 FINAL PUNCH LIST

- A. Prior to the Final Punchlist, certify that systems and equipment are complete, operational, and are in compliance with the Contract Documents.

- B. During the Final Punchlist, provide personnel with access keys, hand held radios, and necessary expertise to operate each system and piece of equipment to demonstrate operational compliance with the Contract Documents.
- C. Any deficiencies noted on the Final Punchlist shall be expeditiously corrected and certified in writing.

END OF SECTION

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## SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Copper building wire rated 600 V or less.
  - 2. Connectors, splices, and terminations rated 600 V and less.

#### 1.2 DEFINITIONS

- A. PV: Photovoltaic.
- B. RoHS: Restriction of Hazardous Substances.
- C. VFC: Variable-frequency controller.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product.
- B. Product Schedule: Indicate type, use, location, and termination locations.
- C. Qualification Data: For testing agency.
- D. Field quality-control reports.

#### 1.4 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 RHH and Type RHW-2: Comply with UL 44.
  2. Type THHN and Type THWN-2: Comply with UL 83.
  3. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
  4. Type XHHW-2: Comply with UL 44.
  5. Type TC-ER: Comply with NEMA WC 70/ICEA S-95-658 and UL 1277.
    - a. Type TC-ER: Cable designed for use with VFCs, with oversized crosslinked polyethylene insulation, spiral-wrapped foil plus 85 percent braided shields with full size drain wire, full sized insulated ground wire, and sunlight- and oil-resistant outer PVC jacket. Provide this cable between VFCs and motor loads as indicated on drawings.

## 2.2 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.

## 2.3 INSULATING TAPE

- A. Provide vinyl plastic tape that meets the requirements of UL 510 and has the following characteristics:
  1. Mil minim thickness.
  2. ASTM D-3005 Standard specification for low-temperature resistant vinyl Chloride plastic pressure-sensitive electrical insulating type – type1.
  3. Rated 600 volts and 150°C, suitable for indoor and outdoor applications.
  4. Retains flexibility, adhesion, and applicable at temperature ranges from 0 through 100°F without loss of physical or electrical properties.
  5. Resistant to abrasion, moisture, alkalis, acid, corrosion, and sunlight
  6. Tape manufacturer: 3M "Scotch Super 88" or approved equal.

## 2.4 MANUFACTURERS

- A. Wire Manufacturers: subject to compliance with requirements, provide products by one of the following (no exceptions):
  1. Southwire Company



2. General Cable
  3. The Okonite Company
  4. Belden
  5. VitaLink
  6. Pyrotenax
- B. Connectors Manufacturers: subject to compliance with requirements, provide products by one of the following (no exceptions):
1. Hubbell
  2. Thomas & Betts
  3. 3M Company

### PART 3 EXECUTION

#### 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders/Branch circuits: Copper; solid for No. 10 AWG and No. 12 AWG; stranded for No. 8 AWG and larger.
- B. VFC Output Circuits Cable: Extra-flexible stranded for all sizes.

#### 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway; Type XHHW-2, single conductors in raceway; Type USE, single conductor in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway; Type XHHW-2, single conductors in raceway.
- E. Feeders Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway;
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

- I. Branch Circuits Installed below Raised Flooring: Type THHN/THWN-2, single conductors in raceway.
- J. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless-steel, wire-mesh, strain relief device at terminations to suit application.
- K. VFC Output Circuits: Type XHHW-2 in metal conduit; Type TC-ER cable with dual tape shield.

### 3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Contract drawings do not indicate size of branch circuit wiring; use No.12 AWG as a minimum wire size for branch circuit wiring. For 20 Ampere branch circuits whose length from the panel to the furthest outlet exceeds 100 feet for 120-volt circuits or 150 feet for 277-volt circuits; use No. 10 AWG or larger for the entire branch circuit installation.
- C. A shared neutral may be utilized for circuits other than circuits used for dimmers, ground fault interrupter receptacles or circuit breakers, isolated ground receptacles, and isolated ground surge suppressor type devices
- D. 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.
- E. 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.
- F. Do not install wire in incomplete conduit runs nor until after concrete work and plastering is completed and moisture is swabbed from the conduits. Eliminate splices where possible. Where necessary, splice in readily accessible pull, junction or outlet box.
- G. Take precautions to avoid entrance of dirt and water into the conduit and cuts. Clean conduits and ducts to remove and pulling compound prior to pulling cables. Do not damage conductor insulation, braid jacket or sheath during installation. Any damaged conductors shall be replaced immediately.
- H. Use pulling means, including fish tape, cable, rope, cable reels on jacks, and basket-weave wire/cable grips, that will not damage cables or raceway. Do not exceed maximum recommended pulling tension of wire and cable
- I. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

- J. 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. Except where lugs are furnished with equipment, 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. Circumferential compression type connector (provide for splices and connections No. 6 AWG and larger):
  - 1. Use for incoming and outgoing cable connections at enclosures and for ground connections.
    - a. Use manufacturer's approved tool and correct size hex head with embossed die number on the connector or lug.
  - 2. Make crimped indentions parallel with insulation putty.
  - 3. Fill voids and irregularities with insulation putty.
  - 4. Cover nearly with four (4) layers of vinyl plastic tape except where insulated covers are permitted; half-lap tape in two (2) directions.
- D. Wiring at Outlets: Install conductor at each outlet, with at least 12 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 according to the project specifications.

### 3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections.
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
  - 2. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services for compliance with requirements:
  - 3. Perform each of the following visual and electrical tests:
    - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line/riser diagram.
    - b. Test bolted connections for high resistance using one of the following:
      - 1) A low-resistance ohmmeter.
      - 2) Calibrated torque wrench.
      - 3) Thermographic survey.
    - c. Inspect compression-applied connectors for correct cable match and indentation.
    - d. Inspect for correct identification.
    - e. Inspect cable jacket and condition.
    - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
    - g. Continuity test on each conductor and cable.
    - h. Uniform resistance of parallel conductors.
    - i. Insulation resistance to comply with ICEA values.
  - 4. Initial Infrared Scanning: After Substantial Completion, but before Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
    - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

- b. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- 5. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
- E. Cables will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports to record the following:
  - 1. Procedures used.
  - 2. Results that comply with requirements.
  - 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION

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## SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Provide a complete grounding system in accordance with the Contract Documents and as specified herein.

#### 1.2 SUBMITTALS

- A. Minimum 1/8" scale floor plan drawings depicting the building ground electrode system as to be installed.
- B. Detailed riser diagram depicting the building ground electrode system and bonding as to be installed.
- C. Product data sheets (cut sheets) for all ground bus bars and other components of the grounding system.
- D. Field test reports.

#### 1.3 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Certified by NETA.

### PART 2 PRODUCTS

#### 2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

#### 2.2 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  - 1. Solid Conductors: ASTM B 3.
  - 2. Stranded Conductors: ASTM B 8.

3. Tinned Conductors: ASTM B 33.
  4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
  5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
  6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
  7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

## 2.3 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Compression type, copper or copper alloy, with two wire terminals.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Cable Tray Ground Clamp: Mechanical type, zinc-plated malleable iron.
- G. Conduit Hubs: Mechanical type, terminal with threaded hub.
- H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- I. Lay-in Lug Connector: Mechanical type, aluminum or copper rated for direct burial terminal with set screw.
- J. Signal Reference Grid Clamp: Mechanical type, stamped-steel terminal with hex head screw.
- K. Straps: Solid copper, cast-bronze clamp or copper lugs. Rated for 600 A.
- L. Tower Ground Clamps: Mechanical type, copper or copper alloy, terminal two-piece clamp.



- M. U-Bolt Clamps: Mechanical type, copper or copper alloy, terminal listed for direct burial.
- N. Water Pipe Clamps:
  - 1. Mechanical type, two pieces with stainless-steel bolts.
    - a. Material: Die-cast zinc alloy.
    - b. Listed for direct burial.
  - 2. U-bolt type with malleable-iron clamp and copper ground connector.

## 2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.
- B. Ground Plates: 1/4-inch-thick, hot-dip galvanized.

## PART 3 EXECUTION

### 3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 2/0 AWG minimum.
  - 1. Bury at least 24 inches below grade.
- C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.
- D. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
  - 1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
  - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.
- E. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
  - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
  - 4. Connections to Structural Steel: Welded connectors.

### 3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.
- B. At utility transformer, ground per utility company requirements and standards.

### 3.3 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor connected to the receptacle grounding terminal. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- E. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service unless otherwise indicated.
- F. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

### 3.4 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

- B. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
- C. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
  - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
  - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- D. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
  - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
  - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
  - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- E. Grounding and Bonding for Piping:
  - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
  - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
  - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- F. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.
- G. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each indicated item, extending around the perimeter of building area or item indicated.

1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.
  2. Bury ground ring not less than 24 inches from building's foundation.
- H. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; using electrically conductive coated steel reinforcing bars or rods, at least 20 feet long. If reinforcing is in multiple pieces, connect together by the usual steel tie wires or exothermic welding to create the required length.

### 3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections with the assistance of a factory-authorized service representative.
- B. Tests and Inspections:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
  2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
  3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
    - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    - b. Perform tests by fall-of-potential method according to IEEE 81.
  4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.
  2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: 5 ohms.

3. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
  4. Substations and Pad-Mounted Equipment: 5 ohms.
  5. Manhole Grounds: 10 ohms.
  6. ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

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## SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
    - a. Hangers.
    - b. Steel slotted support systems.
    - c. Nonmetallic support systems.
    - d. Trapeze hangers.
    - e. Clamps.
    - f. Turnbuckles.
    - g. Sockets.
    - h. Eye nuts.
    - i. Saddles.
    - j. Brackets.
  - 2. Include rated capacities and furnished specialties and accessories.
- B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.
  - 1. Trapeze hangers. Include product data for components.
  - 2. Steel slotted-channel systems.
  - 3. Nonmetallic slotted-channel systems.
  - 4. Equipment supports.
  - 5. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Suspended ceiling components.
  - 2. Structural members to which hangers and supports will be attached.

3. Size and location of initial access modules for acoustical tile.
4. Items penetrating finished ceiling, including the following:
  - a. Lighting fixtures.
  - b. Air outlets and inlets.
  - c. Speakers.
  - d. Sprinklers.
  - e. Access panels.
  - f. Projectors.

## PART 2 PRODUCTS

### 2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.
  1. Channel Width: 1-5/8 inches.
  2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
  6. Channel Dimensions: Selected for applicable load criteria.
- B. Aluminum Slotted Support Systems: Comply with MFMA-4 factory-fabricated components for field assembly.
  1. Channel Width: 1-5/8 inches.
  2. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
  3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  4. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
  5. Channel Dimensions: Selected for applicable load criteria.
- C. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with minimum 13/32-inch-diameter holes at a maximum of 8 inches o.c., in at least one surface.
  1. Channel Width: 1-5/8 inches.
  2. Fittings and Accessories: Products provided by channel and angle manufacturer and designed for use with those items.



3. Fitting and Accessory Materials: Same as those for channels and angles, except metal items may be stainless steel.
  4. Rated Strength: Selected to suit applicable load criteria.
  5. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- D. Conduit and Cable Support Devices: Steel, Stainless-steel or Glass-fiber-resin hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- E. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- G. 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. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
  3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
  4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
  5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
  6. Toggle Bolts: Stainless-steel springhead type.
  7. Hanger Rods: Threaded steel.

## PART 3 EXECUTION

### 3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems unless requirements in this Section are stricter.
- 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 Raceway: Space supports for EMTs, IMCs, and RMCs 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.

### 3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
  - 1. To Wood: Fasten with lag screws or through bolts.
  - 2. To New Concrete: Bolt to concrete inserts.
  - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  - 4. To Existing Concrete: Expansion anchor fasteners.
  - 5. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
  - 6. To Light Steel: Sheet metal screws.
  - 7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

### 3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.

END OF SECTION

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## SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Metal conduits, tubing, and fittings.
  - 2. Nonmetal conduits, tubing, and fittings.
  - 3. Metal wireways and auxiliary gutters.
  - 4. Nonmetal wireways and auxiliary gutters.
  - 5. Surface raceways.
  - 6. Boxes, enclosures, and cabinets.

#### 1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing
- B. FMC: Flexible metal conduit
- C. GRC: Galvanized rigid steel conduit.
- D. MC: Metal Clad Cable
- E. LFMC: Liquid-tight flexible metal conduit
- F. RNC: Rigid nonmetallic conduit

#### 1.3 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
  - 1. Structural members in paths of conduit groups with common supports.
  - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

### PART 2 PRODUCTS

#### 2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. MC: Comply with UL 1569 and NEC article 330.
- D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
  - 1. Comply with NEMA RN 1,
  - 2. External PVC Coating Thickness: 0.040 inch, minimum.
  - 3. Internal urethane coating Thickness: 0.002 inch, minimum.
  - 4. Hot dipped galvanized threads
  - 5. PVC Coating shall be of the same manufacturer of the conduit.
- E. EMT: Comply with ANSI C80.3 and UL 797.
- F. FMC: Comply with UL 1; single strip, continuous, flexible interlocked double-wrapped steel, galvanized inside and outside forming smooth internal wiring channel.
- G. LFMC: Flexible steel conduit with PVC jacket, UV stable, machine tool gray in color, lightweight aluminum core internal construction and complying with UL 360.
- H. Fittings for Metal Conduit Comply with NEMA FB 1 and UL 514:
  - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
  - 2. Fittings for EMT:
    - a. Material: Steel.
    - b. Type: Set screw.
  - 3. 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.
  - 4. Fittings for PVC-coated Rigid Steel Conduits: Minimum PVC thickness of 0.040 inch, 0.002 inch thickness of internal urethan, overlapping sleeves protecting threaded joints. All conduit bodies shall be NEMA 4x Rated with encapsulated stainless steel screws.
  - 5. Fittings for LFMC: Body, gland and lock nut shall be steel of malleable iron. Ground cone shall be steel, sealing ring and insulator shall be blue molded thermoplastic at 150°C (221°F) maximum.
  - 6. Fittings for GRC: Threaded rigid steel conduit fittings. Comply with NEMA FB 2.10.
- I. Joint Compound for 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 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. RNC: Type EPC-40-PVC for 90°C, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. Materials must have tensile strength of 7,000-7,200 psi at 73.4°F, flexural strength of 12,000 psi and compressive strength of 9,000 psi.
- D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- E. Raceway, fittings, and cement must be produced by the same manufacturer who must have had a minimum of ten (10) years' experience in manufacturing of these products.

## 2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
  - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- C. Wireway Covers: Hinged cover secured with captive screws unless otherwise indicated.
- D. Finish: Manufacturer's standard enamel finish NEMA 250 rated.

## 2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS

- A. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Description: Fiberglass polyester, extruded and fabricated to required size and shape, without holes or knockouts. Cover shall be gasketed with oil-resistant gasket material and fastened with captive screws treated for corrosion resistance. Connections shall be flanged and have stainless-steel screws and oil-resistant gaskets.

- C. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- D. Solvents and Adhesives: As recommended by conduit manufacturer.

## 2.5 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:
  - 1. Refer to drawings for location(s), type(s), and quantity(s) of surface metal raceway.
    - a. Surface finish: be satin, anodized #204 type clear, Class R1 mil-Spec with minimum anodized finish of .004" unless otherwise noted.
- C. Surface Nonmetallic Raceways: Two- or three-piece construction, complying with UL 5A, and manufactured of rigid PVC with texture and color selected by Architect from manufacturer's standard colors. Product shall comply with UL 94 V-0 requirements for self-extinguishing characteristics.

## 2.6 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.
- D. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- F. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
  - 1. Listing and Labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.



- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.
- I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- J. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- K. Gangable boxes are allowed.
- L. Cabinets:
  - 1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
  - 2. Hinged door in front cover with flush latch and concealed hinge.
  - 3. Key latch to match panelboards.
  - 4. Metal barriers to separate wiring of different systems and voltage.
  - 5. Accessory feet where required for freestanding equipment.
  - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.7 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

- A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
  - 1. Tests of materials shall be performed by an independent testing agency.
  - 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
  - 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012 and traceable to NIST standards.

## 2.8 MANUFACTURERS

- A. Raceway and Fitting Manufacturers: subject to compliance with requirements, provide products by one of the following (no exceptions):
  - 1. Wheatland Tube
  - 2. Allied Tube & Conduit
  - 3. Thomas & Betts
  - 4. Hubble
  - 5. Legrand
  - 6. Calbond
  - 7. Western Tube and Conduit
  - 8. Republic Conduit

## PART 3 EXECUTION

### 3.1 RACEWAY APPLICATION

- A. The following application must be adhered to. Raceways installed that are not conforming to this listing must be removed and replace with specified material at no additional expense.

| Raceway Types                                   | Applications   |
|---|--|
| Galvanized Rigid Steel Conduit (GRC)            | Where exposed to mechanical injury, where specifically required; indoors where exposed to moisture; where required by codes and for all circuits in excess of 600 volts. Outdoor locations, sump and ejector pits, elevator pits, loading docks, garage, rooftops and gymnasium.   |
| PVC Coated Galvanized Rigid Steel Conduit (GRC) | Where exposed to extreme outdoor and indoor corrosion and or weather conditions: Stub out of Concrete applications. In applications where two (2) UL Listed Layers of Corrosion protection is required and Hot Dipped Galvanized Conduit as Primary Protection is listed PVC Coating is listed as Primary Corrosion is also UL Listed. |
| Electrical Metallic tubing (EMT)                | Use in every instance except where another material is not specified.  |
| Metal Clad Cable (MC)                           | Lighting and receptacle branch circuits concealed in dry hollow spaces of a building. May not be used in areas where it would be subjected to physical damage, or where prohibited by Code.  |
| Flexible Metal Conduit                          | Use in dry areas for connections to lighting fixtures in hung ceilings, connections to equipment installed in removable panels of hung ceilings; at all transformer or equipment raceway connections where sound and vibration   |

|                                     |   |
|-------------------------------------|---|
|                                     | isolation is required.  |
| Liquid-Tight Flexible Metal Conduit | Use in areas subject to moisture where flexible metal conduit is unacceptable, at connections to all motors, and all raised floor areas.  |
| Rigid Non-Metallic Conduit          | Schedule 40 - Where raceways are in a slab below grade levels; for raceway duct banks.<br>Schedule 80 - For underground raceways outside of the building which are not encased in concrete. |
| Wireways and Auxiliary Gutters      | Where indicated on the Contract Documents and as otherwise specifically required.   |
| Boxes and Enclosures                | NEMA 250, Type 1, except use NEMA 250, Type 4 in kitchens and damp/or wet locations. Outdoors use NEMA 250, Type 3R.  |

- B. Provide separate raceways for all wiring systems, including security, data, paging, low voltage et al. All 480Y/277 volt wiring must be kept independent of 208Y/120 volt wiring. Emergency system wiring must be kept independent of the normal system wiring. Provide grounding conductor within all circuits. Minimum size 3/4-inch for home runs and 1-inch minimum for power distribution. Wiring of each type and system must be installed in separate raceways.
- C. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid Galvanized Steel Conduit (GRC): Use threaded rigid steel conduit fittings. Comply with NEMA FB 2.10.
  2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
  3. EMT: Use setscrew steel fittings. Comply with NEMA FB 2.10.
  4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- E. Install surface raceways only where indicated on Drawings.
- F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

### 3.2 INSTALLATION

- A. 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.
- B. 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.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. 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.
- 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. Provide one (1) empty 3/4 inch raceway for each three (3) spare unused poles or spaces of each flush-mounted panelboard. Terminate empty 3/4 inch conduits in a junction box, which after completion is accessible to facilitate future branch circuit extension. Provide pull lines in each raceway.
- J. Raceways in hung ceilings shall be installed on and secured to the slab or primary structural members of the ceiling, not to lathing channels or T-bars, Z-bars or other elements which are direct supports of the ceiling panels. Secure conduit firmly to the steel with clips and fittings designed for that purpose. Install as high as possible but not less than 1'-0" above the hung ceilings.
- K. Raceways Embedded in Slabs:
  - 1. Install no raceway in the concrete slab except with the permission of the Structural Engineer and written consent of the Owner.
  - 2. Do not install raceways larger than 1-1/4 inch size in structural concrete slabs.
  - 3. In no case will the installation of raceways be permitted to interfere with proper placement of principal reinforcement.
  - 4. Place raceways in the structural slabs between the upper and lower layers of reinforcing steel. Careful bending of the conduits is required.

5. Space the raceways embedded in concrete slabs not less than eight (8) inches on centers and as widely spaced as possible where they converge at panels or junction boxes.
  6. Install raceways running parallel to slabs supports, such as beams, columns and structural walls, not less than 12 inches from such supporting elements.
  7. Secure saddle supports for conduit, outlet boxes, junction boxes, inserts, etc. with suitable adhesives during concrete pour of the slab to prevent displacement.
  8. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
- L. Stub-ups to Above Recessed Ceilings:
1. Use EMT for raceways.
  2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- M. 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.
- N. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- O. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.
- P. 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.
- Q. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- R. 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.
- S. 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.
- T. 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.
- U. 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.
- V. 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.
- W. 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. Where otherwise required by NFPA 70.
- X. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- Y. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
  2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
  3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
  4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.

5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- Z. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
  1. Use LFMC in damp or wet locations subject to severe physical damage.
  2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.
- AA. OUTLET, JUNCTION, AND PULL BOXES
  1. Provide outlet, junction, and pull boxes as indicated on the Contract Documents and as required for the complete installation of the various electrical systems, and to facilitate proper pulling of the cables. Size the junction boxes and pull boxes per the NEC. Size the boxes on any empty conduit systems as if containing conductors of No.4 AWG.
  2. The exact location of outlets and equipment is governed by the structural conditions and obstructions, or other equipment items. When necessary, relocate outlets so that when fixtures or equipment are installed, they will be symmetrically located according to the room layout and will not interfere with other work or equipment. Verify final location of outlets, panels equipment, etc., with the Architect prior to installation.
  3. Back-to-back outlets in the same wall, or "thru-wall" type boxes are not permitted. Provide 12-inch minimum spacing for outlets shown on opposite sides of a common wall to minimize sound transmission.
  4. Fit outlet boxes in finished ceilings or walls with appropriate covers, set flush with the finished surface. Where more than one (1) switch or device is located at one (1) point, use gang boxes and covers unless otherwise indicated. Sectional switch boxes or utility boxes are not permitted. Provide tile box or 4 inch square box with tile ring in masonry walls not plastered or furred. Where drywall material is utilized, provide plaster ring. Provide outlet boxes of type and size suitable for the specific application. Where outlet boxes contain two (2) or more 277 volt devices, or where devices occur of different applied voltages, or where normal and emergency devices occur in the same box, provide suitable barrier(s).
  5. All outlet and device box depths shall have sufficient depth to prevent damage to the conductors when devices or utilization equipment are installed as intended in the box.
  6. Types of Boxes and Fittings for Various Locations:

| Location                               | Type                      |
|--|---------------------------|
| Outlet                                 | Galvanized pressed steel  |
| Outlet exposed to moisture or outdoors | Cast type conduit fitting |

|  |  |
|--|--|
| Splice                                 | Galvanized pressed steel   |
| Splice exposed to moisture or outdoors | Cast type conduit fitting or sheet metal (4½" x 5" x 3" minimum) |
| Pull or Junction                       | Cast type conduit fitting or sheet metal (4½" x 5" x 3" minimum) |
| Pull or Junction - Outdoors            | Aluminum (4½" x 5" x 3" minimum)                                 |
| Terminal                               | Sheet steel (6" x 6" x 3" minimum)                               |
| Terminal - Outdoors                    | Aluminum (6" x 6" x 3" minimum)                                  |

**BB. PULL BOX SPACING**

1. Provide pull boxes so no individual conduit run contains more than the equivalent of four (4) quarter bends (360° total).
2. Conduit Sizes 1¼" and Larger:
  - a. Provide boxes to prevent cable from being excessively twisted, stretched or flexed during installation.
  - b. Provide boxes so that maximum pulling tensions do not exceed the cable manufacturer's recommendations.
  - c. Provide support racks for boxes with multiple sets of conductors so that the conductors do not rest on any metal work inside the box.
3. Conduit Sizes 1 inch and Smaller, provide boxes at every (Maximum Distances):

| Distance | Run Type   |
|----------|--|
| 150 feet | straight runs  |
| 100 feet | runs with one (1) 90° bend or equivalent                 |
| 75 feet  | runs with two (2) 90° bends or equivalent                |
| 50 feet  | runs with three (3) or (4) four 90° bends or equivalent. |

- CC. 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 center of box unless otherwise indicated.
- DD. 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.
- EE. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- FF. Locate boxes so that cover or plate will not span different building finishes.



- GG. 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.
- HH. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- II. Set metal floor boxes level and flush with finished floor surface.
- JJ. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

### 3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
  - 1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified elsewhere in the project specifications for pipe less than 6 inches in nominal diameter.
  - 2. Install backfill as specified elsewhere in the project specifications.
  - 3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified elsewhere in the project specifications.
  - 4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
    - a. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
  - 5. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

### 3.4 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."

### 3.5 FIRESTOPPING

- A. Install firestopping at penetrations of all fire-rated floor and wall assemblies, per the project specifications.

### 3.6 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

## SECTION 260534 - MANHOLES AND HANDHOLES

### PART 1 GENERAL

#### 1.1 Summary

- A. This Section Includes the following:
  - 1. Handholes.
  - 2. Accessories.

#### 1.2 definitions

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casting materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as a component of a duct bank.
- C. Duct Bank:
  - 1. Two or more duct installed in parallel, with or without additional casting materials.
  - 2. Multiple duct banks.
- D. GRC: Galvanized rigid (steel) conduit.
- E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

#### 1.3 SUBMITTALS

- A. Product Data:
  - 1. Manholes and handholes.
  - 2. Accessories.
  - 3. Warning tape.
  - 4. Warning planks.
- B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures:  
Include dimensioned plans, elevations, sections, details, attachments to other work, and accessories, including frame and cover design, grounding detail, cable rack inserts, sumps and pulling irons.

#### 1.4 QUALITY ASSURANCE

- A. Comply with the latest applicable provisions and latest recommendations of the governing codes and the Contract Documents.

- B. Power Utility Company Standards.
- C. U.L. Listing of all products.

## 1.5 COORDINATION

- A. Coordinate layout and installation of manholes and handholes with the final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of manholes and handholes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features.

## PART 2 PRODUCTS

### 2.1 HANDHOLES

- A. Description: Factory-fabricated, reinforced pre-cast concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover shall form top of the enclosure and shall have a load rating consistent with that of a handhole.
  - 1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing stainless-steel bolts.
  - 2. Frame and Cover: Weatherproof steel frame, with steel cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing stainless-steel bolts.
  - 3. Cover Legend: Molded lettering, "ELECTRIC." "COMMUNICATIONS."
  - 4. Configuration: Units shall be designed for flush burial and have a closed bottom.
  - 5. Extensions and Slabs: Designed to mate with the bottom of enclosure. Same material as the enclosure.
  - 6. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
    - a. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.
    - b. Window openings shall be framed with at least two (2) additional No. 4 steel reinforcing bars in concrete around each opening.
  - 7. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
  - 8. Handholes shall have inserts for cable racks and pulling-in irons installed before concrete is poured.
- B. Acceptable Manufacturers:

1. Quazite
2. Christy Concrete Products
3. Oldcastle Precast Group.
4. Utility Concrete Products, LLC.

## 2.2 HANDHOLES OTHER THAN PRECAST CONCRETE

- A. Description: Comply with SCTE 77.
  1. Configuration: Units shall be designed for flush burial and have closed bottom.
  2. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with the enclosure.
  3. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
  4. Cover Legend: Molded lettering, "ELECTRIC." "COMMUNICATIONS."
  5. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings.
  6. Duct Entrance Provisions: Duct-terminating fittings shall mate with the entering ducts for secure, fixed installation in the enclosure wall.
  7. Handholes shall have factory-installed inserts for cable racks and pulling-in irons.
- B. Polymer Concrete Handholes with Polymer Concrete Cover: Molded of sand and aggregate, bound together with a polymer resin, and reinforced with steel or fiberglass or a combination of the two. Handholes shall comply with the requirements of SCTE 7 Tier loading applicable to the installation location.
  1. Acceptable Manufacturers:
    - a. Quazite
    - b. Armorcast Products Company.
    - c. Oldcastle Enclosure Solutions
    - d. Hubbell Power Systems
- C. Fiberglass Handholes with Polymer Concrete Frame and Cover: Sheet-molded, fiberglass-reinforced, polyester resin enclosure joined to polymer concrete top ring or frame.
  1. Acceptable Manufacturers:
    - a. Quazite
    - b. Armorcast Products Company.
    - c. Oldcastle Enclosure Solutions.
    - d. Hubbell Power Systems.
- D. Fiberglass Handholes: Molded of fiberglass-reinforced polyester resin, with covers of hot-dip galvanized-steel diamond plate.
  1. Acceptable Manufacturers:
    - a. Quazite
    - b. Oldcastle Enclosure Systems
    - c. Armorcast Products Company

d. Hubbell Power Systems.

2.3 CAST-IN-PLACE MANHOLES

- A. Description: Underground utility structures, constructed in place, complete with accessories, hardware, and features. Include concrete knockout panels for conduit entrance and sleeve for ground rod.
- B. Materials: Comply with ASTM C 858.
  - 1. Concrete shall have a minimum compressive strength of 3000 psi (20 MPa).

2.4 SOURCE QUALITY CONTROL

- A. Test and inspect precast concrete utility structures according to ASTM C 1037 and SCTE 77.

PART 3 EXECUTION

3.1 GENERAL

- A. Excavation, shoring, bracing, back-filling and grading provided by other section.
- B. Manholes shall be constructed as shown on the Contract Drawings. Manholes shall not be constructed until final conduit grading has been determined, including any field changes required by underground interferences. Shop drawings shall be submitted for all manhole details that differ in any way from those shown on the Contract Drawings.
- C. Cables to be secured with tie-wraps. Cable racks shall be fiber.
- D. Provide a copper clad steel ground rod, 3/8 inch by 10 feet long, in each manhole. All noncurrent-carrying metal parts in manholes and handholes including metallic sheaths of cables, shall be connected to the ground rod by a bare copper ground conductor. Install the ground rod with top protruding 4 inches above manhole floor.
- E. Provide a cast iron sump frame and cover for each manhole. Provide 12-by 12-by 6-inch deep sump. Excavate below sump 6 inches and fill sump bottom with clean gravel. Slope floor of manhole 1/8-inch per foot to the edge of the sump.
- F. Waterproof exterior surfaces, joints, and interruptions of manholes after concrete has cured 28 days minimum.
- G. Attach cable racks to inserts after manhole.
- H. Manholes and handholes are shown on the Contract Documents in approximate locations. The exact location shall be field determined after careful consideration of other utilities, grading, and paving.

- I. In paved areas, set top of frame and cover flush with finished surface. In unpaved areas, set top of frame and cover approximately ½ inch above finished grade.
- J. The installation of manholes shall be in an excavated area free of obstructions for a minimum 6 inches around outside perimeter, with a 6 inch compact gravel base of uniform thickness and level. The preparation of the base shall insure no settlement. Backfill shall consist of good compactable material, such as pea gravel, sand or clean earth fill. Backfilling should be done progressively from bottom to top surface. Minimum earth cover from roof of manhole to finished grade shall be 8 inches.
- K. Concrete encased duct banks entering wall may be cast in the concrete or enter through opening of suitable dimensions and arrangement. Where openings are provided, caulk the space between duct bank and walls tight with lead wool or other suitable material. Reinforce iron of the ductbank to be connected to the wall.
- L. Flush end bells shall be mounted on side walls where duct enters.
- M. Duct entrances shall be carefully planned via the field for best application of cable pulling and racked. All cables shall be secured with tie-wraps to porcelain saddles.
- N. Waterproofing shall be done in accordance with manufacturer's instructions.
- O. Collar shall be cast concrete rings, stacked to required height. Set height in field per final grade elevations.

### 3.2 UNDERGROUND ENCLOSURE APPLICATION

- A. Handholes for 600 V and Less, Including Telephone, Communications, and Data Wiring:
  - 1. Units in Roadways and Traffic Paths: Precast concrete.
  - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 22 structural load rating.
  - 3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Heavy-duty fiberglass units with polymer concrete frame and cover, SCTE 77, Tier 8 structural load rating.
  - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf "Light-Duty" vertical loading.

### 3.3 EARTHWORK

- A. Excavation and Backfill: Do not use heavy-duty, hydraulic-operated, compaction equipment.

- B. Restore surface features at areas disturbed by excavation and reestablish original grades unless otherwise indicated on the Contract Documents. Replace removed sod immediately after backfilling is completed.

### 3.4 INSTALLATION OF CONCRETE MANHOLES AND HANDHOLES

- A. Precast Concrete Handhole and Manhole Installation:
  - 1. Comply with ASTM C 891 unless otherwise indicated.
  - 2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
  - 3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, and compacted to same density as adjacent undisturbed earth.
- B. Elevations:
  - 1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
  - 2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
  - 3. Install handholes with bottom below the frost line.
  - 4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
- C. Drainage: Install drains in bottom of manholes where indicated.
- D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
  - 1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
  - 2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening.
- E. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors.
- F. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- G. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches for manholes and 2 inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- H. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

### 3.5 INSTALLATION OF HANDHOLES OTHER THAN PRECAST CONCRETE



- A. Install handholes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use pull box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.
- B. Unless otherwise indicated, support units on a level 6-inch- thick bed of crushed stone or gravel, graded and compacted to same density as adjacent undisturbed earth.
- C. Elevation: Set so cover surface will be flush with finished grade.
- D. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors.
- E. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- F. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
  - 1. Concrete: 3000 psi (20 kPa), 28-day strength.
  - 2. Dimensions: 10 inches wide by 12 inches or as indicated.

### 3.6 GROUNDING

- A. Ground underground ducts and utility structures.

### 3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  - 1. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in this division."
- B. Correct deficiencies and retest as specified above to demonstrate compliance.

### 3.8 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

## SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Metal conduits and fittings, including GRC and PVC-coated steel conduit.
  - 2. Rigid nonmetallic duct.
  - 3. Flexible nonmetallic duct.
  - 4. Duct accessories.
  - 5. Precast concrete handholes.
  - 6. Polymer concrete handholes and boxes with polymer concrete cover.

#### 1.2 DEFINITIONS

- A. Direct Buried: Duct or a duct bank that is buried in the ground, without any additional casing materials such as concrete.
- B. Duct: A single duct or multiple ducts. Duct may be either installed singly or as component of a duct bank.
- C. Duct Bank: Two or more ducts installed in parallel, with or without additional casing materials.
- D. GRC: Galvanized rigid (steel) conduit.
- E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

#### 1.3 SUBMITTALS

- A. Product Data:
  - 1. Duct bank materials, including separators and miscellaneous components.
  - 2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
  - 3. Warning tape.
  - 4. Warning planks.
- B. Shop drawings for dimension underground structure: including plans, elevations, sections, details, attachments to other work, and accessories, including the following:
  - 1. Duct entry provisions, including locations and duct sizes.
  - 2. Reinforcement details.
  - 3. Grounding details.

- 4. Duct bank coordination drawings showing dimensioned duct profiles and coordination with other utilities and underground structures. Include plans and sections drawing to scale, and show bends and locations of expansion fittings.
- C. Submittal results of field tests.
- D. Record documents: show dimensional locations of all underground ducts, handholes, and manholes.

## PART 2 PRODUCTS

### 2.1 UNDERGROUND DUCT SYSTEM

- A. Contractor shall furnish and install raceways and fittings for an underground duct system, as indicated on the Contract Drawings and specified herein.
- B. All bends at underground duct system shall be per the manufacturer's bending requirements.
- C. The minimum bend radius for Telco carrier conduit, under any circumstances shall be greater than 12 times the conduit diameter. Comply with Utility Company requirements.
- D. Raceways shall transform from EPC (electrical plastic conduit) PVC to rigid galvanized steel conduit within 10 feet of any foundation walls. Run EPC PVC duct bank to the manholes. Contractor shall furnish and install proper couplings to accommodate aforementioned transition.
- E. Where offsets are required to clear obstructions and other underground services, a maximum of 5° angle will be allowed at duct joints.
- F. Ducts shall be installed so as to drain to the manholes. Ducts entering into the point of entry (P.O.E.) room shall be installed with upward slope of minimum of 0.125 inch/foot.
- G. All raceways as previously described shall utilize a mandrel of sufficient size to thoroughly clear raceways of all obstructions prior to the installation of any wiring.
- H. All concrete construction, excavation and backfill for the underground ductbank system shall be described under other sections of the project specifications. Red dye shall be added to the concrete mixture.
- I. All conduits penetrating into the buildings shall be totally sealed in order to prevent any migration of water through the ductbank into the building.
- J. Prior to backfilling of the underground duct system, provide a yellow (with black, lettering) warning tape, 1'-0" from finished grade, stating, "CAUTION ELECTRIC LINE BURIED BELOW" above all electrical ductbank, and "CAUTION TELECOMMUNICATIONS CABLE BELOW" above all Telecom ductbank.

## 2.2 CONDUITS

- A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.
- B. PVC NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by the same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

## 2.3 NON-METALLIC DUCTS AND DUCT ACCESSORIES

- A. General
- B. Schedule EPC-40-PVC conduit shall be used for all concrete encased duct banks.
- C. PVC conduits shall not be used within the building area unless otherwise noted.
- D. All penetrations through floor slabs or foundation walls shall be rigid steel conduits. No EPC conduit shall be used in or through any floor slab.
- E. PVC conduits shall not be allowed under paved areas, which are subjected to vehicular traffic. Concrete encased rigid steel conduit shall be used.
- F. Acceptable Manufacturers:
  - 1. Carlon Product Corporation
  - 2. Excelon
  - 3. Southern Pipe, Inc.

## 2.4 Duct Accessories:

- A. Duct Separators (Spacers)
  - 1. Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
  - 2. Duct bank shall be encased in concrete with at least three inches of concrete at the top and bottom and two inches on each side. A horizontal and vertical separation between the ducts of 3 inches shall be maintained by installing Underground Devices High Impact Polystyrene Spacers. Spacers shall be interlocked horizontally only. Along the length of the duct run spacers shall be staggered at least 6 inches vertically and shall be placed at an interval of 4 spacers per 20 feet.
  - 3. Telco carrier ducts shall be separated from electrical ducts by a minimum of 36" and shall cross electrical ductbanks at 90-degree angle only, when unavoidable.
  - 4. In general, duct spacers should be of the type recommended by the conduit manufacturers and approved by the Utility Company. Maximum spacing for 4" - 6" conduits shall not exceed 10 feet.

## PART 3 EXECUTION

### 3.1 UNDERGROUND DUCT APPLICATION

- A. Ducts for Electrical Cables over 600 V: NEMA Type EPC-40 -PVC, in concrete-encased duct bank unless otherwise indicated.
- B. Ducts for Electrical Feeders 600 V and Less: NEMA Type EPC-40-PVC, in concrete-encased duct bank unless otherwise indicated.
- C. Ducts for Electrical Feeders 600 V and Less: NEMA Type EPC-80-PVC, in direct-buried duct bank unless otherwise indicated.
- D. Ducts smaller than 2" trade size for Electrical Branch Circuits: NEMA Type EPC-40-PVC, in direct-buried duct bank unless otherwise indicated.
- E. Ducts smaller 2" and larger trade size for Electrical Branch Circuits: NEMA Type EPC-80-PVC, in direct-buried duct bank unless otherwise indicated.
- F. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: NEMA Type EPC-40-PVC, in concrete-encased duct bank unless otherwise indicated.

### 3.2 EARTHWORK

- A. Excavation and Backfill: Do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restore surface features at areas disturbed by excavation and reestablish original grades unless otherwise indicated.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work.

### 3.3 DUCT INSTALLATION

- A. Concrete for conduit envelopes shall be as required or as specified under other Divisions of the project specifications. Red dye shall be added to concrete mixture. Concrete shall extend at least 3 inches beyond exterior surface of each conduit in bank.
- B. Concrete envelopes may be poured directly against sides of trenches provided the trench wall is clean, even and free of loose material. Remove loose dirt and extraneous material. Concrete shall be spaced during pouring to eliminate voids under and between conduits and to prevent honeycombing of exterior surfaces. Power-driven tampers or agitators shall not be used. Secure bolts sufficiently to prevent movement during concrete placement.

- C. Concrete envelops between manholes, or between the manhole and building, shall be poured in a single operation. Where more than one (1) pour is necessary, provide  $\frac{3}{4}$  inch reinforcing rod dowels extending 18 inches into concrete on each side of joint. Concrete envelopes installed over extensive area of disturbed earth shall have a separate concrete base.
- D. Concrete envelopes that cross other conduits or pipelines or are run under roads and driveways shall be reinforced. Provide reinforcement where envelopes connect to manhole and building walls. Concrete envelopes that terminate for future extension shall have dowels as specified for joints between pours. Reinforcement shall be as required; consult with the structural engineer.
- E. Trenches shall not be backfilled until concrete envelopes have had sufficient time to set. After concrete envelopes have set, nonmetallic conduits shall be cleared with mandrel of the same size as the conduit.
- F. Cap ends of spare conduits 5 feet beyond pavement and protect them from mechanical damage. Mark the location of conduit ends with concrete monuments, 6 inches in diameter by 18 inches long, set flush in the ground with "S/C" indented in the top.
- G. Arrange multiple conduits as shown on the Contract Drawings. Make minor changes in location, or cross-sectional arrangement as necessary. Where conduit runs cannot be installed as shown because of conditions not discoverable prior to digging of trenches, request the Architect's instructions before further work is done. Coordinate this work with other outside service work.
- H. Seal active and spare conduits that enter the building with oakum or other plastic expandable compound until conductors are ready for installation.
- I. Provide labeled pull string for all conduits.
- J. Slope: Pitch ducts a minimum slope of 0.125 inch/ft down toward the manholes and handholes and away from the buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.
- K. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 12 times the conduit diameter, both horizontally and vertically, at other locations unless otherwise indicated.
- L. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- M. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches on center for 5-inch ducts, and vary proportionately for other duct sizes.

- N. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 ft. outside the building wall without reducing duct line slope away from the building and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition.
- O. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.
- P. Pulling Cord: Install 100-lbf test nylon cord in ducts, including spares. Label each line.

#### 3.4 Concrete-Encased Ducts:

- A. Support ducts on duct separators.
- B. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 ft. of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
- C. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
- D. Pouring Concrete: Spade concrete carefully during pours. Use a plank to direct concrete down sides of bank assembly to trench bottom.
- E. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated.
- F. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting; otherwise, use forms.
- G. Minimum Space between Ducts: 3 inches between ducts and exterior envelope wall, 2 inches between ducts for like services, and 4 inches between power and signal ducts.
- H. Depth: Install top of duct bank at least 24 inches below the finished grade in areas not subject to deliberate traffic, and at least 36 inches below finished grade in deliberate traffic paths for vehicles unless otherwise indicated.
- I. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
  - 1. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.



2. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of base. Install insulated grounding bushings on terminations at equipment.

### 3.5 Direct-Buried Duct and Duct Bank:

- A. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
- B. Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 ft. of duct. Stagger spacers approximately 6 inches between tiers.
- C. Excavate trench bottom to provide firm and uniform support for duct bank.
- D. Install backfill.
- E. After installing first tier of ducts, backfill and compact. After placing last tier, hand-place backfill to 4 inches over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction.
- F. Install ducts with a minimum of 3 inches between ducts for like services and 6 inches between power and signal ducts.
- G. Depth: Install top of duct bank at least 36 inches below finished grade unless otherwise indicated.
- H. Set elevation of bottom of duct bank below the frost line.
- I. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
  1. Steel conduits to ducts with adapters designed for this purpose and encase coupling with 3 inches of concrete.
  2. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

### 3.6 GROUNDING

- A. Ground underground ducts in accordance with the "Grounding and Bonding of Electrical System" specification section.

### 3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. Demonstrate capability and compliance with requirements on the completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through each duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Grounding: Test manhole grounding to ensure electrical continuity of bonding and grounding connections. Measure ground resistance at each ground rod and report results. Use an instrument specifically designed for ground-resistance measurements.
4. Water Tightness: Make internal inspection of manholes 3 months after completion of construction for indications of water ingress. Where leakage is noted, remove water and seal leak sources. Reinspect after 2 months and reseal remaining leak sources. Repeat process at 2 month intervals until leaks are corrected.

B. Correct deficiencies and retest as specified above to demonstrate compliance.

### 3.8 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts

END OF SECTION

## SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
  - 2. Sleeve-seal systems.
  - 3. Sleeve-seal fittings.
  - 4. Grout.
  - 5. Silicone sealants.

#### 1.2 SUBMITTALS

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

### 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. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- F. Sleeves for Rectangular Openings:
  - 1. Material: Galvanized sheet steel.
  - 2. Minimum Metal Thickness:

- a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
- b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

## 2.2 SLEEVE-SEAL FITTINGS

- A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

## 2.3 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.

## 2.4 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.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

## PART 3 EXECUTION

### 3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
  - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

- a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
    - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
  2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
  4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
  5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
  2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. 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.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

### 3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

### 3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

## SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Color and legend requirements for raceways, conductors, and warning labels and signs.
  - 2. Labels.
  - 3. Bands and tubes.
  - 4. Tapes and stencils.
  - 5. Tags.
  - 6. Signs.
  - 7. Cable ties.
  - 8. Paint for identification.
  - 9. Fasteners for labels and signs.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.
- B. Identification Schedule: For each piece of electrical equipment and electrical system components to be an index of nomenclature for electrical equipment and system components used in identification signs and labels. Use same designations indicated on Drawings.
- C. Delegated-Design Submittal: For arc-flash hazard study.

### PART 2 PRODUCTS

#### 2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Comply with NFPA 70E requirements for arc-flash warning labels.

- F. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

## 2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
  - 1. Color shall be factory applied.
  - 2. Colors for 208/120-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
    - c. Phase C: Blue.
  - 3. Colors for 240-V Circuits:
    - a. Phase A: Black.
    - b. Phase B: Red.
  - 4. Colors for 480/277-V Circuits:
    - a. Phase A: Brown.
    - b. Phase B: Orange.
    - c. Phase C: Yellow.
  - 5. Color for Neutral: White.
  - 6. Color for Equipment Grounds: Green.
  - 7. Colors for Isolated Grounds: Green with white stripe.
- C. Warning Label Colors:
  - 1. Identify system voltage with black letters on an orange background.
- D. Warning labels and signs shall include, but are not limited to, the following legends:
  - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  - 2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

## 2.3 LABELS



- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends.
- B. Snap-around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3-mil-thick, polyester or vinyl flexible label with acrylic pressure-sensitive adhesive.
  - 1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over the legend. Labels sized such that the clear shield overlaps the entire printed legend.
  - 2. Marker for Labels: Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Polyester or Vinyl, thermal, transfer-printed, 3-mil-thick, multicolor, weather- and UV-resistant, pressure-sensitive adhesive labels, configured for intended use and location.
  - 1. Minimum Nominal Size:
    - a. 1-1/2 by 6 inches for raceway and conductors.
    - b. 3-1/2 by 5 inches for equipment.
    - c. As required by authorities having jurisdiction.

## 2.4 BANDS AND TUBES

- A. Snap-around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches long, with diameters sized to suit diameters and that stay in place by gripping action.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at a maximum of 200 deg F. Comply with UL 224.

## 2.5 TAPES AND STENCILS

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mils thick by 1 to 2 inches wide; compounded for outdoor use.
- C. Tape and Stencil: 4-inch-wide black stripes on 10-inch centers placed diagonally over orange background and is 12 inches wide. Stop stripes at legends.
- D. Floor Marking Tape: 2-inch-wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

- E. Underground-Line Warning Tape:
  - 1. Tape:
    - a. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
    - b. Printing on tape shall be permanent and shall not be damaged by burial operations.
    - c. Tape material and ink shall be chemically inert and not subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
  - 2. Color and Printing:
    - a. Comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, ANSI Z535.4, and ANSI Z535.5.
    - b. Inscriptions for Red-Colored Tapes: "ELECTRIC LINE, HIGH VOLTAGE".
    - c. Inscriptions for Orange-Colored Tapes: "TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE".
- F. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

## 2.6 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch, with stamped legend, punched for use with self-locking cable tie fastener.
- B. Nonmetallic Preprinted Tags: Polyethylene tags, 0.015-inch-thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.
- C. Write-on Tags:
  - 1. Polyester Tags: 0.010-inch-thick, with corrosion-resistant grommet and cable tie for attachment.
  - 2. Marker for Tags: Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

## 2.7 SIGNS

- A. Baked-Enamel Signs:
  - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
  - 2. 1/4-inch grommets in corners for mounting.
  - 3. Nominal Size: 7 by 10 inches.
- B. Metal-Backed Butyrate Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396-inch galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
  2. 1/4-inch grommets in corners for mounting.
  3. Nominal Size: 10 by 14 inches.
- C. Laminated Acrylic or Melamine Plastic Signs:
1. Engraved legend.
  2. Thickness:
    - a. For signs up to 20 sq. in., minimum 1/16 inch.
    - b. For signs larger than 20 sq. in., 1/8 inch thick.
    - c. Engraved legend with black letters on white face.
    - d. Punched or drilled for mechanical fasteners with 1/4-inch grommets in corners for mounting.
    - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

## 2.8 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black, except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, and Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 Deg F according to ASTM D 638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black.
- C. Plenum-Rated Cable Ties: Self-extinguishing, UV stabilized, one piece, and self-locking.
1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 Deg F according to ASTM D 638: 7000 psi.
  3. UL 94 Flame Rating: 94V-0.
  4. Temperature Range: Minus 50 to plus 284 deg F.
  5. Color: Black.

## 2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

### 3.2 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.
- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
  - 1. Secure tight to surface of conductor, cable, or raceway.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- I. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch-high letters for emergency instructions at equipment used for power transfer.

- J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.
- K. Accessible Fittings for Raceways: Identify the covers of each junction and pull box of the following systems with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. "EMERGENCY POWER."
  - 2. "POWER."
  - 3. "UPS."
- L. Vinyl Wraparound Labels:
  - 1. Secure tight to surface of raceway or cable at a location with high visibility and accessibility.
  - 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to the location and substrate.
- M. Snap-around Labels: Secure tight to surface at a location with high visibility and accessibility.
- N. Self-Adhesive Wraparound Labels: Secure tight to surface at a location with high visibility and accessibility.
- O. Self-Adhesive Labels:
  - 1. On each item, install unique designation label that is consistent with wiring diagrams, schedules, and operation and maintenance manual.
  - 2. 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.
- P. Snap-around Color-Coding Bands: Secure tight to surface at a location with high visibility and accessibility.
- Q. Heat-Shrink, Preprinted Tubes: Secure tight to surface at a location with high visibility and accessibility.
- R. Marker Tapes: Secure tight to surface at a location with high visibility and accessibility.
- S. Self-Adhesive Vinyl Tape: Secure tight to surface at a location with high visibility and accessibility.
  - 1. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding.
- T. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.

- U. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's written instructions.
- V. Underground Line Warning Tape:
  - 1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches overall.
  - 2. Limit use of underground-line warning tape to direct-buried cables.
- W. Metal Tags:
  - 1. Place in a location with high visibility and accessibility.
- X. Nonmetallic Preprinted Tags:
  - 1. Place in a location with high visibility and accessibility.
- Y. Baked-Enamel Signs:
  - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on minimum 1-1/2-inch-high sign; where two lines of text are required, use signs minimum 2 inches high.
- Z. Metal-Backed Butyrate Signs:
  - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.
- AA. Laminated Acrylic or Melamine Plastic Signs:
  - 1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
  - 2. Unless otherwise indicated, provide a single line of text with 1/2-inch-high letters on 1-1/2-inch-high sign; where two lines of text are required, use labels 2 inches high.
- BB. Cable Ties: General purpose, for attaching tags, except as listed below:
  - 1. Outdoors: UV-stabilized nylon.
  - 2. In Spaces Handling Environmental Air: Plenum rated.

END OF SECTION

## SECTION 260923 - LIGHTING CONTROL DEVICES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Photoelectric switches.
  - 2. Standalone daylight-harvesting dimming controls.
  - 3. Indoor occupancy and vacancy sensors.
  - 4. Switchbox-mounted occupancy sensors.
  - 5. Digital timer light switches.
  - 6. Emergency shunt relays.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Show installation details for the following:
    - a. Daylight-harvesting dimming controls.
    - b. Occupancy sensors.
    - c. Vacancy sensors.
  - 2. Interconnection diagrams showing field-installed wiring.
  - 3. Include diagrams for power, signal, and control wiring.

#### 1.3 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.
- B. Software and Firmware Operational Documentation:
  - 1. Software operating and upgrade manuals.
  - 2. Program Software Backup: On USB media or on manufacturer's website. Provide names, versions, and website addresses for locations of installed software.
  - 3. Device address list.
  - 4. Printout of software application and graphic screens.

#### 1.4 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Faulty operation of lighting control software.
    - b. Faulty operation of lighting control devices.
  - 2. Warranty Period: Five (5) years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 OUTDOOR PHOTOELECTRIC SWITCHES

- A. Description: Solid state, with dry contacts, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A, and compatible with ballasts and LED lamps.
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Light-Level Monitoring Range: 1.5 to 10 fc, with an adjustment for turn-on and turn-off levels within that range, and a directional lens in front of the photocell to prevent fixed light sources from causing turn-off.
  - 3. Time Delay: Fifteen-second minimum, to prevent false operation.
  - 4. Surge Protection: Metal-oxide varistor.
  - 5. Mounting: Twist lock complies with NEMA C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.
  - 6. Failure Mode: Luminaire stays ON.

### 2.2 DAYLIGHT-HARVESTING DIMMING CONTROLS

- A. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.
  - 1. Lighting control set point is based on two lighting conditions:
    - a. When no daylight is present (target level).
    - b. When significant daylight is present.
  - 2. System programming is done with two hand-held, remote-control tools.
    - a. Initial setup tool.
    - b. Tool for occupants to adjust the target levels by increasing the set point up to 25 percent, or by minimizing the electric lighting level.
- B. Ceiling-Mounted Dimming Controls: Solid-state, light-level sensor unit, with integrated or separate power pack mounted on luminaire, to detect changes in indoor lighting levels that are perceived by the eye.



- C. Electrical Components, Devices, and Accessories:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Sensor Output: 0- to 10-V dc to operate luminaires. Sensor is powered by controller unit.
  - 3. Light-Level Sensor Set-Point Adjustment Range: 20 to 60 fc.
- D. Power Pack: Dry contacts rated for 20A ballast or LED load at 120V and 277V AC, for 13A tungsten at 120V AC, and for 1 HP at 120V AC. Sensor has 24V DC, 150mA, Class 2 power source, as defined by NFPA 70.
  - 1. LED status lights to indicate load status.
  - 2. Plenum rated.
- E. Power Pack: Digital controller capable of accepting 3 RJ45 inputs with two outputs rated for 20A incandescent or LED load at 120V and 277V AC, for 16A ballast load or LED at 120V and 277V AC, and for 1 HP at 120V AC. Sensor has 24V DC Class 2 power source, as defined by NFPA 70.
  - 1. With integral current monitoring
  - 2. Compatible with digital addressable lighting interface.
  - 3. Plenum rated.

## 2.3 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. General Requirements for Sensors:
  - 1. Wall and Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
  - 2. Dual technology.
  - 3. Integrated or Separate power pack.
  - 4. Hardwired or Wireless connection to switch and BAS; and BAS and lighting control system.
  - 5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 6. Operation:
    - a. Occupancy Sensor: 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, adjustable over a minimum range of 1 to 30 minutes.
    - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.

- c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
  - 7. Power: Low voltage or Line voltage.
  - 8. Mounting:
    - a. Sensor: Suitable for mounting in any position on a standard outlet box.
    - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
    - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
  - 9. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
  - 10. Bypass Switch: Override the "on" function in case of sensor failure.
  - 11. Automatic Light-Level Sensor: Adjustable from 2 to 100 fc; turn lights off when selected lighting level is present.
- B. Dual-Technology Type: Wall or 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-minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
  - 3. Detection Coverage: Select sensor(s) to provide full coverage of room and detect occupancy anywhere within the room where installed.

## 2.4 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, 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. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
  - 3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
  - 4. Sensing Technology – Dual Technology.

## 2.5 DIGITAL TIMER LIGHT SWITCH

- A. Description: Combination digital timer and conventional switch lighting control unit. Switchbox-mounted, backlit LCD display, with selectable time interval.
1. Listed and labeled as defined in NFPA 70 and marked for intended location and application.
  2. The digital time switch shall be programmable to turn lights off after a preset time.
  3. Time switch shall be a completely self-contained control system that replaces the standard toggle switch. It shall have a ground wire and ground strap for safety. Switching mechanism shall be a latching air gap relay.
  4. Zero Crossing Circuitry shall be used to increase the relay life, protect from the effects of inrush current, and increase the switch's longevity.
  5. Time switch shall be compatible with all electronic ballasts, motor loads, compact fluorescent and inductive loads. Triac and other harmonic generating devices shall not be allowed.
  6. Time switch shall have no minimum load requirement and shall be capable of controlling all types of light sources.
  7. Time scroll feature shall allow manual overriding of the preset time-out period.
  8. Time switch shall have the option for a one second light flash warning at five minutes before the timer runs out and twice when the countdown reaches one minute (when used to control lighting loads).
  9. Time switch shall have the option for a beep warning that shall sound every five seconds once the time switch countdown reaches one minute.
  10. Time switch shall have manual feature for timer reset where pressing the ON/OFF switch for more than 2 seconds resets the timer to the programmed time-out period.
  11. Time switch shall have an electroluminescent backlit Liquid Crystal Display that shows the timer's countdown.
  12. Time switch shall fit behind a decorator style faceplate. The calibration switch for setting time-out, time scroll, one second light flash, and beep warning shall be concealed to prevent tampering of adjustments and hardware.
  13. Time-out period shall be adjustable in increments of 5 minutes from 5 minutes to 1 hour, and in increments of 15 minutes from 1 hour to 12 hours.
  14. Time switch shall be capable of operating as an ON/OFF switch.
  15. For safety, the time switch shall have a 100% OFF override switch with no leakage current to the load.
  16. For safety, in the event there is an open circuit in the AC line such as a ballast or lamp failure, the time switch shall automatically switch to OFF mode

## 2.6 EMERGENCY SHUNT RELAY

- A. Description: NC, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: 120 and 277 V.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 SENSOR INSTALLATION

- A. Comply with NECA 1.
- B. 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.
- C. 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.

#### 3.3 WIRING INSTALLATION

- A. Comply with NECA 1.
- B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.
- C. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

#### 3.4 IDENTIFICATION

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
  1. Identify controlled circuits in lighting contactors.

2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.

- B. Label time switches and contactors with a unique designation.

### 3.5 LIGHTING SYSTEM FUNCTIONAL TESTING

- A. The lighting control system manufacturer, manufacturer's authorized representative, or a qualified testing agency shall perform all functional testing required by the 2015 International Energy Conservation Code, Section C408.

- B. Functional Testing:

1. Prior to passing final inspection, the manufacturer's authorized representative shall provide evidence that the lighting control systems have been tested to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the construction documents and manufacturer's instructions.

- C. Occupancy Sensor Controls:

1. Certify that the occupancy sensors have been located and aimed in accordance with manufacturer recommendations.
  - a. For projects with seven or fewer sensors, each sensor shall be tested.
  - b. For projects with more than seven sensors, testing shall be done for each unique combination of sensor type and space geometry. Where multiples of each unique combination of sensor type and space geometry are provided, not less than 10 percent, but in no case less than one, of each combination shall be tested. Where 30 percent or more of the tested controls fail, all remaining identical combinations shall be tested.
2. For occupancy sensor controls to be tested, verify the following:
  - a. Where occupancy sensor controls include status indicators, verify correct operation.
  - b. The controlled lights turn off or down to the permitted level within the required time.
  - c. For auto-on sensors, the lights turn on to the permitted level when an occupant enters the space.
  - d. For manual-on sensors, the lights turn on only when manually activated.
  - e. The lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.

- D. Time Switch Controls:

1. Where time switch controls are provided, the following procedures shall be performed:
  - a. Confirm that the time-switch control is programmed with accurate weekday, weekend and holiday schedules.

- b. Provide documentation to the owner of time switch controls programming including weekday, weekend, holiday schedules, and set-up and preference program settings.
    - c. Verify the correct time and date in the time switch.
    - d. Verify that any battery backup is installed and energized.
    - e. Verify that the override time limit is set to not more than 2 hours.
  - 2. Simulate occupied condition. Verify and document the following:
    - a. All lights can be turned on and off by their respective area control switch.
    - b. The switch only operates lighting in the enclosed space in which the switch is located.
  - 3. Simulate unoccupied condition. Verify and document the following:
    - a. Nonexempt lighting turns off.
    - b. Manual override switch allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.
- E. Daylight Responsive Controls:
  - 1. Where daylight responsive controls are provided, the following shall be verified:
    - a. Control devices have been properly located, field calibrated and set for accurate set points and threshold light levels.
    - b. Daylight controlled lighting loads adjust to light level set points in response to available daylight.
    - c. The locations of calibration adjustment equipment are readily accessible only to authorized personnel.
- F. Documentation Requirements:
  - 1. Documents certifying that the lighting controls meet documented performance criteria of the IECC are to be provided to the building owner within 90 days from the date of receipt of the certificate of occupancy.

### 3.6 TRAINING

- A. The lighting control system manufacturer or the manufacturer's authorized representative shall conduct formal training for all users of the automatic lighting control systems.

END OF SECTION

## SECTION 262416 - PANELBOARDS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Distribution panelboards.
  - 2. Lighting and appliance branch-circuit panelboards.

#### 1.2 DEFINITIONS

- A. ATS: Acceptance testing specification.
- B. GFCI: Ground-fault circuit interrupter.
- C. GFEP: Ground-fault equipment protection.
- D. HID: High-intensity discharge.
- E. MCCB: Molded-case circuit breaker.
- F. SPD: Surge protective device.
- G. VPR: Voltage protection rating.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of panelboard.
  - 1. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
  - 2. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details.
  - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
  - 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
  - 4. Detail bus configuration, current, and voltage ratings.
  - 5. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 6. Include evidence of NRTL listing for SPD as installed in panelboard.

7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include wiring diagrams for power, signal, and control wiring.
9. Key interlock scheme drawing and sequence of operations.
10. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device. Include an Internet link for electronic access to downloadable PDF of the coordination curves.

C. Qualification Data: For testing agency.

D. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

#### 1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in other sections, include the following:
  - a. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  - b. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

#### 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. Keys: Two spares for each type of panelboard cabinet lock.
2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

#### 1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: ISO 9001 or 9002 certified.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

A. Handle and prepare panelboards for installation according to NEMA PB 1.



## 1.8 FIELD CONDITIONS

- A. Environmental Limitations:
  - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
    - b. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Notify Owner no fewer than five business days in advance of proposed interruption of electric service.
  - 2. Do not proceed with interruption of electric service without Owner's written permission.
  - 3. Comply with NFPA 70E.

## 1.9 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.
- B. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace SPD that fails in materials or workmanship within specified warranty period.

## PART 2 PRODUCTS

### 2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- 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 PB 1.

- D. Comply with NFPA 70.
- E. Enclosures: Flush and Surface-mounted, dead-front cabinets.
  - 1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
    - b. Outdoor Locations: NEMA 250, Type 3.
    - c. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
    - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
    - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
  - 2. Height: 84 inches maximum.
  - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims shall cover all live parts and shall have no exposed hardware.
  - 4. Gutter Extension and Barrier: Same gage and finish as panelboard enclosure; integral with enclosure body. Arrange to isolate individual panel sections.
  - 5. Finishes:
    - a. Panels and Trim: Galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    - b. Back Boxes: Galvanized steel.
    - c. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
- F. Incoming Mains:
  - 1. Location: Convertible between top and bottom.
  - 2. Main Breaker: Main lug interiors up to 400 amperes shall be field convertible to main breaker.
- G. Phase, Neutral, and Ground Buses:
  - 1. Material: Hard-drawn copper, 98 percent conductivity, depending on rating of panelboard.
    - a. Plating shall run entire length of bus.
    - b. Bus shall be fully rated the entire length.
  - 2. Interiors shall be factory assembled into a unit. Replacing switching and protective devices shall not disturb adjacent units or require removing the main bus connectors.
  - 3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
  - 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure. Do not mount neutral bus in gutter.
  - 5. Split Bus: Vertical buses divided into individual vertical sections.

- H. Conductor Connectors: Suitable for use with conductor material and sizes.
  - 1. Material: Hard-drawn copper, 98 percent conductivity.
  - 2. Terminations shall allow use of 75 deg C rated conductors without derating.
  - 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
  - 4. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
  - 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.
  - 6. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  - 7. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate on load side of main device unless otherwise noted on plans.
  - 8. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material and with matching insulating covers. Locate at same end of bus as incoming lugs or main device.
- I. NRTL Label: Panelboards or load centers shall be labeled by an NRTL acceptable to authority having jurisdiction for use as service equipment with one or more main service disconnecting and overcurrent protective devices. Panelboards or load centers shall have meter enclosures, wiring, connections, and other provisions for utility metering. Coordinate with utility company for exact requirements.
- J. Future Devices: Panelboards or load centers shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
  - 1. Percentage of Future Space Capacity: See drawings.
- K. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.
  - 1. Panelboards and overcurrent protective devices rated 240 V or less shall have short-circuit ratings as shown on Drawings, but not less than 10,000 A rms symmetrical.
  - 2. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V shall have short-circuit ratings as shown on Drawings, but not less than 14,000 A rms symmetrical.

## 2.2 PERFORMANCE REQUIREMENTS

- A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1 or Type 2.

## 2.3 DISTRIBUTION PANELBOARDS

- A. Approved manufactures:
  - 1. Square D: I-Line
  - 2. Eaton: Pow-R-Line 4,
  - 3. Siemens: Type P4/P5
  - 4. General Electric: Spectra Series
- B. Panelboards: NEMA PB 1, distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
  - 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers where individual positive-locking device requires mechanical release for removal.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers where individual positive-locking device requires mechanical release for removal.

#### 2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Approved manufacturers:
  - 1. Eaton
  - 2. Square D
  - 3. Siemens
  - 4. General Electric
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Circuit breaker or lugs only.
- D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Door-in-door construction with concealed hinges; secured with multipoint latch with tumbler lock; keyed alike. Outer door shall permit full access to the panel interior. Inner door shall permit access to breaker operating handles and labeling, but current carrying terminals and bus shall remain concealed.

#### 2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
  - 1. Electronic Trip Circuit Breakers:
    - a. 100 percent rated

- b. RMS sensing.
- c. Field-replaceable rating plug or electronic trip.
- d. Digital display of settings, trip targets, and indicated metering displays.
- e. Multi-button keypad to access programmable functions and monitored data.
- f. Ten-event, trip-history log. Each trip event shall be recorded with type, phase, and magnitude of fault that caused the trip.
- g. Integral test jack for connection to portable test set or laptop computer.
- h. Field-Adjustable Settings:
  - 1) Instantaneous trip.
  - 2) Long- and short-time pickup levels.
  - 3) Long and short time adjustments.
  - 4) Ground-fault pickup level, time delay, and I squared T response.
- 2. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
- 3. GFEP Circuit Breakers: Class B ground-fault protection (30-mA trip).
- 4. Arc-Fault Circuit Interrupter Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
- 5. Subfeed Circuit Breakers: Vertically mounted.
- 6. MCCB Features and Accessories:
  - a. Standard frame sizes, trip ratings, and number of poles.
  - b. Breaker handle indicates tripped status.
  - c. UL listed for reverse connection without restrictive line or load ratings.
  - d. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
  - e. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and HID lighting circuits.
  - f. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
  - g. Communication Capability: Circuit-breaker-mounted or integral communication module with functions and features compatible with power monitoring and control system.
  - h. Shunt Trip: 24-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
  - i. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
  - j. Rating Plugs: Three-pole breakers with ampere ratings greater than 150 amperes shall have interchangeable rating plugs or electronic adjustable trip units.

- k. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
- l. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
- m. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
- n. Multipole units enclosed in a single housing with a single handle or factory assembled to operate as a single unit.
- o. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

## 2.6 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Computer-generated circuit directory mounted inside panelboard door with transparent plastic protective cover.
  - 1. Circuit directory shall identify specific purpose with detail sufficient to distinguish it from all other circuits.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Comply with NECA 1.
- C. Install panelboards and accessories according to NEMA PB 1.1.
- D. Equipment Mounting:
  - 1. Attach panelboard to the vertical finished or structural surface behind the panelboard.
- E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- F. Mount top of trim at a height so that the operating handle of the top-most switch or circuit breaker, in ON position, is not higher than 79 inches (2000 mm) above finished floor or grade, unless otherwise indicated.
- G. Mount panelboard cabinet plumb and rigid without distortion of box.
- H. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- I. Mount surface-mounted panelboards to steel slotted supports 5/8 inch in depth. Orient steel slotted supports vertically.
- J. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
  - 2. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written instructions.
- K. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- L. Install filler plates in unused spaces.
- M. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.
- N. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

### 3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with the project specification requirements for identification.
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with the project specifications.
- D. Device Nameplates: Label each branch circuit device in power panelboards with a nameplate complying with the project specifications.
- E. Install warning signs complying with requirements of the project specifications.

### 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.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers and low-voltage surge arrestors stated in NETA ATS, Paragraph 7.6 Circuit Breakers and Paragraph 7.19.1 Surge Arrestors, Low-Voltage. Do not perform optional tests. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
- D. Panelboards will be considered defective if they do not pass tests and inspections.



- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results, with comparisons of the two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in the Electrical Power System Study, required per specification section 260573 and furnished by the Electrical Contractor.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Engineer of effect on phase color coding.
  - 1. Measure loads during period of normal facility operations.
  - 2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by the Owner.
  - 3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
  - 4. Tolerance: Maximum difference between phase loads, within a panelboard, shall not exceed 20 percent.
  - 5. Update panelboard directories accordingly, and provide updated directories to Owner within five business days of load balancing.

### 3.6 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

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## SECTION 262726 - WIRING DEVICES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Straight-blade convenience, isolated-ground, and tamper-resistant receptacles.
  - 2. GFCI receptacles.
  - 3. Twist-locking receptacles.
  - 4. Pendant cord-connector devices.
  - 5. Cord and plug sets.
  - 6. Toggle switches.
  - 7. Decorator-style convenience.
  - 8. Wall-box dimmers.
  - 9. Wall plates.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: One for each type of device and wall plate specified, in each color specified.

### 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 application.
- B. Comply with NFPA 70.
- C. Devices for Owner-Furnished Equipment:
  - 1. Receptacles: Match plug configurations.
  - 2. Cord and Plug Sets: Match equipment requirements.
- D. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

#### 2.2 STRAIGHT-BLADE RECEPTACLES

- A. Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
- B. Isolated-Ground, Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
  - 1. Description: Straight blade; equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.
- C. Tamper-Resistant Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

## 2.3 GFCI RECEPTACLES

- A. General Description:
  - 1. 125 V, 20 A, straight blade, feed-through type.
  - 2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
  - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

## 2.4 TWIST-LOCKING RECEPTACLES

- A. Twist-Lock, Single Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
- B. Twist-Lock, Isolated-Ground, Single Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
  - 1. Grounding: Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

## 2.5 PENDANT CORD-CONNECTOR DEVICES

- A. Description:
  - 1. Matching, locking-type plug and receptacle body connector.
  - 2. NEMA WD 6 Configurations L5-20P and L5-20R, heavy-duty grade, and FS W-C-596.
  - 3. Body: Nylon, with screw-open, cable-gripping jaws and provision for attaching external cable grip.

4. External Cable Grip: Woven wire-mesh type made of high-strength, galvanized-steel wire strand, matched to cable diameter, and with attachment provision designed for corresponding connector.

## 2.6 CORD AND PLUG SETS

- A. Description:
  1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
  2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
  3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

## 2.7 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
- C. Pilot-Light Switches: 120/277 V, 20 A.
  1. Description: Single pole, with LED-lighted handle, illuminated when switch is off.
- D. Key-Operated Switches: 120/277 V, 20 A.
  1. Description: Single pole, with factory-supplied key in lieu of switch handle.
- E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.
- F. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

## 2.8 WALL-BOX DIMMERS

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider or toggle switch; with single-pole or three-way switching. Comply with UL 1472.
- C. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

- D. LED Lamp Dimmer Switches: Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 20 percent of full brightness.

## 2.9 WALL PLATES

- A. 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: As selected by the Architect.
  - 3. Material for Unfinished Spaces: Galvanized steel.
  - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

## 2.10 FINISHES

- A. Device Color:
  - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
  - 2. Wiring Devices Connected to Emergency Power System: Red.
  - 3. Isolated-Ground Receptacles: Orange.
- B. Wall Plate Color: As selected by the Architect.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

| TYPICAL MOUNTING HEIGHTS                       |   |
|--|---|
| DEVICE   | MOUNTING HEIGHT   |
| Wall switches, card readers                    | 48 inches above finished floor to center  |
| Receptacle outlets, data outlets, CATV outlets | 18 inches above finished floor to center  |
| Receptacle outlets – above counter             | 42 inches above finished floor to center, or 8 inches to center above countertops |
| Wall telephone outlets                         | 48 inches above finished floor to center  |
| Clock outlets                                  | 96 inches above finished floor to center, or 6 inches below ceiling.              |

|  |   |
|--|---|
|  | Above doors, centered between door trim and ceiling |
|--|---|

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 meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
  - a. Cut back and pigtail, or replace all damaged conductors.
  - b. Straighten conductors that remain and remove corrosion and foreign matter.
  - c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
  8. Tighten unused terminal screws on the device.
  9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
- E. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the right.
- F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- G. Dimmers:
1. Install dimmers within terms of their listing.
  2. Verify that dimmers used for fan-speed control are listed for that application.
  3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.
- I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.
- 3.2 GFCI RECEPTACLES
- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.
- 3.3 IDENTIFICATION
- A. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.
- 3.4 FIELD QUALITY CONTROL
- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Tests for Convenience Receptacles:
1. Line Voltage: Acceptable range is 105 to 132 V.



2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
  3. Ground Impedance: Values of up to 2 ohms are acceptable.
  4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
  5. Using the test plug, verify that the device and its outlet box are securely mounted.
  6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions remove malfunctioning units and replace with new ones, and retest as specified above.
- D. Wiring device will be considered defective if it does not pass tests and inspections.

END OF SECTION

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## SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Nonfusible switches.
  - 3. Receptacle switches.
  - 4. Shunt trip switches.
  - 5. Molded-case circuit breakers (MCCBs).
  - 6. Molded-case switches.
  - 7. Enclosures.

#### 1.2 SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
  - 5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF electronic format.
- B. Shop Drawings: For enclosed switches and circuit breakers.
  - 1. Include plans, elevations, sections, details, and attachments to other work.
  - 2. Include wiring diagrams for power, signal, and control wiring.

#### 1.3 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.

#### 1.4 FIELD CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
  - 2. Altitude: Not exceeding 6600 feet.

#### 1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.

### PART 2 PRODUCTS

#### 2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

#### 2.2 FUSIBLE SWITCHES

- A. Manufacturer shall be the same as the switchboards and panelboards.
- B. Type HD, Heavy Duty:
  - 1. Single throw.
  - 2. Three or six pole. Provide six pole for connection to motors requiring six motor leads.
  - 3. 600-V ac.
  - 4. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
  - 5. 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. Lugs: Mechanical type, suitable for number, size, and conductor material.
5. Service-Rated Switches: Labeled for use as service equipment.

## 2.3 NONFUSIBLE SWITCHES

- A. Manufacturer shall be the same as the switchboards and panelboards.
- B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-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. Type HD, Heavy Duty, Six Pole, Single Throw, 600-V ac, 200 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.
- D. Accessories:
  1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  4. Lugs: Mechanical type, suitable for number, size, and conductor material.
  5. Service-Rated Switches: Labeled for use as service equipment.

## 2.4 RECEPTACLE SWITCHES

- A. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible and Nonfusible Switches: as indicated on the drawings.
- B. Interlocking Linkage: Provided between the receptacle and switch mechanism to prevent inserting or removing plug while switch is in the on position, inserting any plug other than specified, and turning switch on if an incorrect plug is inserted or correct plug has not been fully inserted into the receptacle.
- C. Receptacle: Polarized, three-phase, four-wire receptacle (fourth wire connected to enclosure ground lug).

## 2.5 SHUNT TRIP SWITCHES

- A. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with Class J fuse block and 200-kA interrupting and short-circuit current rating.
- B. Type HD, Heavy-Duty, Three Pole, Single-Throw Fusible Switch: UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, with clips or bolt pads to accommodate specified fuses; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- C. Type HD, Heavy-Duty, Three Pole, Single-Throw Nonfusible Switch: UL 98 and NEMA KS 1; integral shunt trip mechanism; horsepower rated, lockable handle with capability to accept three padlocks; interlocked with cover in closed position.
- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, with a control power transformer of enough capacity to operate shunt trip, pilot, indicating and control devices.

## 2.6 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturer shall be the same as the switchboards and panelboards.
- B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.
- D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated.
- E. MCCBs shall be equipped with a device for locking in the isolated position.
- F. Lugs shall be suitable for 194 deg F rated wire, sized according to the 167 deg F (75 deg C) temperature rating in NFPA 70.
- G. Standards: Comply with UL 489 and NEMA AB 3, with interrupting capacity to comply with available fault currents.

- H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
  - 1. Instantaneous trip.
  - 2. Long- and short-time pickup levels.
  - 3. Long- and short-time time adjustments.
  - 4. Ground-fault pickup level, time delay, and I-squared t response.
- K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- L. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- M. Ground-Fault Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- N. Ground-Fault Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- O. Features and Accessories:
  - 1. Standard frame sizes, trip ratings, and number of poles.
  - 2. Lugs: Mechanical or Compression type, suitable for number, size, trip ratings, and conductor material.
  - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
  - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
  - 5. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system.
  - 6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
  - 7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
  - 8. Alarm Switch: One NO/NC contact that operates only when circuit breaker has tripped.

9. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
10. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function.
11. Electrical Operator: Provide remote control for on, off, and reset operations.

## 2.7 MOLDED-CASE SWITCHES

- A. Manufacturer shall be the same as the switchboards and panelboards.
- B. Description: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.
- C. Features and Accessories:
  1. Standard frame sizes and number of poles.
  2. Lugs:
    - a. Mechanical or Compression type, suitable for number, size, trip ratings, and conductor material.
    - b. Lugs shall be suitable for 194 deg F rated wire, sized according to the 167 deg F temperature rating in NFPA 70.
  3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
  4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
  5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
  6. Alarm Switch: One NO/NC contact that operates only when switch has tripped.
  7. Key Interlock Kit: Externally mounted to prohibit switch operation; key shall be removable only when switch is in off position.
  8. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
  9. Electrical Operator: Provide remote control for on, off, and reset operations.

## 2.8 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: The enclosure shall be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (NEMA 250 Type 1) gray baked enamel paint, or electrodeposited on cleaned, phosphatized galvanized steel (NEMA 250 Types 3R, 12).



- C. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.
- D. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- E. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

### 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.
  - 1. Commencement of work shall indicate Installer's acceptance of the areas and conditions as satisfactory.

#### 3.2 PREPARATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
  - 1. Notify Owner no fewer than five business days in advance of proposed interruption of electric service.
  - 2. Indicate method of providing temporary electric service.
  - 3. Do not proceed with interruption of electric service without Owner's written permission.
  - 4. Comply with NFPA 70E.

#### 3.3 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
  - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  - 2. Outdoor Locations: NEMA 250, Type 3.
  - 3. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.

4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

### 3.4 INSTALLATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain code required workspace clearances and required clearances for equipment access doors and panels, regardless of location indicated on the drawings.
- B. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- C. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NFPA 70 and NECA 1.

### 3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in the Electrical Power System Study, required per specification section 260573 and furnished by the Electrical Contractor.

END OF SECTION

## SECTION 265119 - LED INTERIOR LIGHTING

### PART 1 PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section includes the following types of LED luminaires:
  - 1. Lighting Fixtures.
  - 2. Materials.
  - 3. Finishes.
  - 4. Fixture support.

#### 1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product.
  - 1. Arrange in order of luminaire designation.
  - 2. Include data on features, accessories, and finishes.
  - 3. Include physical description and dimensions of luminaires.
  - 4. Include emergency lighting units, including batteries and chargers.
  - 5. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
  - 6. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project IES LM-79 and IES LM-80.
    - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

- B. Shop Drawings: For nonstandard or custom luminaires.
  - 1. Include plans, elevations, sections, and mounting and attachment details.
  - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.
- C. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

#### 1.4 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

#### 1.6 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

### PART 2 PRODUCTS

#### 2.1 PRODUCTS

- A. Refer to the Lighting Fixture Schedule on the drawings for the specified fixtures and options.

#### 2.2 LUMINAIRE 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. Standards:

1. ENERGY STAR certified.
  2. California Title 24 compliant.
  3. NRTL Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by an NRTL.
  4. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
  5. UL Listing: Listed for damp location.
  6. Recessed luminaires shall comply with NEMA LE 4.
- C. CRI as indicated on the drawings. CCT as indicated on the drawings.
- D. Rated lamp life of minimum 50,000 hours to L70.
- E. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- F. Internal driver.

## 2.3 MATERIALS

- A. Metal Parts:
1. Free of burrs and sharp corners and edges.
  2. Sheet metal components shall be steel unless otherwise indicated.
  3. Form and support to prevent warping and sagging.
- B. 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.
- C. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels 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 lamp characteristics:
    - a. "USE ONLY" and include specific lamp type.
    - b. Lamp diameter, shape, size, wattage, and coating.
    - c. CCT and CRI for all luminaires.

## 2.4 METAL FINISHES

- A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

## 2.5 LUMINAIRE SUPPORT

- A. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- B. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage.
- C. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- D. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 TEMPORARY LIGHTING

- A. If approved by the Owner, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

#### 3.3 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Install lamps in each luminaire.
- D. Supports:
  - 1. Sized and rated for luminaire weight.
  - 2. Able to maintain luminaire position after cleaning and relamping.
  - 3. Provide support for luminaire without causing deflection of ceiling or wall.
  - 4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and vertical force of 400 percent of luminaire weight.
- E. Flush-Mounted Luminaire Support:

1. Secured to outlet box.
  2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
  3. Trim ring flush with finished surface.
- F. Wall-Mounted Luminaire Support:
1. Attached to structural members in walls or Attached to a minimum 20 gauge backing plate attached to wall structural members.
  2. Do not attach luminaires directly to gypsum board.
- G. Ceiling-Mounted Luminaire Support:
1. Ceiling mount with minimum two 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
  2. Pendant mount with 5/32-inch- diameter aircraft cable supports adjustable to 120 inches in length.
  3. Ceiling mount with hook mount.
- H. Suspended Luminaire Support:
1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
  2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
  3. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.
  4. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- I. Ceiling-Grid-Mounted Luminaires:
1. Secure to any required outlet box.
  2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
  3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

### 3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
  2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.

- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

### 3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.
  - 1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
  - 2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.

END OF SECTION



## SECTION 265219 - EMERGENCY AND EXIT LIGHTING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Emergency lighting units.
  - 2. Exit signs.
  - 3. Luminaire supports.

#### 1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Fixture: See "Luminaire" Paragraph.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of emergency lighting unit, exit sign, and emergency lighting support.
  - 1. Include data on features, accessories, and finishes.
  - 2. Include physical description of the unit and dimensions.
  - 3. Battery and charger for light units.
  - 4. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
  - 5. Include photometric data and adjustment factors based on laboratory tests, complying with IES LM-45, for each luminaire type.
    - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: For nonstandard or custom luminaires.
  - 1. Include plans, elevations, sections, and mounting and attachment details.

2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Product Schedule:

1. For emergency lighting units. Use same designations indicated on Drawings.
2. For exit signs. Use same designations indicated on Drawings.

#### 1.4 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturer's laboratory that is accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

#### 1.6 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
- B. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

### PART 2 PRODUCTS

#### 2.1 PRODUCTS

- A. Refer to Lighting Fixture Schedule on the drawings for the specified fixtures and options.

#### 2.2 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- 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. NRTL Compliance: Fabricate and label emergency lighting units, exit signs, and batteries to comply with UL 924.

- C. Comply with NFPA 70 and NFPA 101.
- D. Comply with NEMA LE 4 for recessed luminaires.
- E. Comply with UL 1598 for fluorescent luminaires.
- F. Lamp Base: Comply with ANSI C81.61 or IEC 60061-1.
- G. Bulb Shape: Complying with ANSI C79.1.
- H. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body and compatible with ballast.
  - 1. Emergency Connection: Operate lamp(s) continuously full lumen output upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
  - 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
  - 3. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Less than 0 deg F or exceeding 104 deg F, with an average value exceeding 95 deg F over a 24-hour period.
    - b. Ambient Storage Temperature: Not less than minus 4 deg F and not exceeding 140 deg F.
    - c. Humidity: More than 95 percent (condensing).
    - d. Altitude: Exceeding 3300 feet.
  - 4. Nightlight Connection: Operate lamp continuously at 40 percent of rated light output.
  - 5. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
    - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  - 6. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
  - 7. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
- I. External Type: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.

1. Emergency Connection: Operate LED lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.
2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
3. Nightlight Connection: Operate lamp in a remote luminaire continuously.
4. Charger: Fully automatic, solid-state, constant-current type.
5. Housing: NEMA 250, Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly shall be located no less than half the distance recommended by the ballast or emergency power unit manufacturer, whichever is less.
6. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
7. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
8. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

## 2.3 EMERGENCY LIGHTING

- A. General Requirements for Emergency Lighting Units: Self-contained units.
- B. Emergency luminaires: as indicated on the drawings.
- C. Emergency Lighting Unit: as indicated on the drawings.
- D. Remote Emergency Lighting Units: as indicated on the drawings.

## 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. Lamps for AC Operation: LED; 50,000 hours minimum rated lamp life.
  2. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

## 2.5 MATERIALS

- A. Metal Parts:
  1. Free of burrs and sharp corners and edges.
  2. Sheet metal components shall be steel unless otherwise indicated.

3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access:
  1. Smooth operating, free of light leakage under operating conditions.
  2. Designed to permit relamping without use of tools.
  3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Housings:
  1. As indicated on the drawings.
- D. Conduit: Electrical metallic tubing, minimum 3/4 inch in diameter.

## 2.6 METAL FINISHES

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Comply with NECA 1.
- B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- C. Supports:
  1. Sized and rated for luminaire and emergency power unit weight.
  2. Able to maintain luminaire position when testing emergency power unit.
  3. Provide support for luminaire and emergency power unit without causing deflection of ceiling or wall.

4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire and emergency power unit weight and vertical force of 400 percent of luminaire weight.
- D. Wall-Mounted Luminaire Support:
  1. Do not attach luminaires directly to gypsum board.
- E. Suspended Luminaire Support:
  1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
  2. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
  3. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- F. Ceiling Grid Mounted Luminaires:
  1. Secure to any required outlet box.
  2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.
  3. Use approved devices and support components to connect luminaire to ceiling grid and building structure in a minimum of four locations, spaced near corners of luminaire.

### 3.3 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
  1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. Prepare test and inspection reports.

### 3.4 STARTUP SERVICE

- A. Perform startup service:
  1. Charge emergency power units and batteries minimum of 24 hours and conduct one-hour discharge test.

### 3.5 ADJUSTING

- A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
  - 1. Inspect all luminaires. Replace lamps, emergency power units, batteries, signs, or luminaires that are defective.
    - a. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  - 2. Conduct short-duration tests on all emergency lighting.

END OF SECTION

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## SECTION 283100 - FIRE DETECTION AND ALARM

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes:
  - 1. Fire-alarm control panel (FACP).
  - 2. Manual fire alarm pull stations.
  - 3. System smoke detectors.
  - 4. Carbon Monoxide detectors.
  - 5. Heat detectors.
  - 6. Beam Smoke detectors.
  - 7. Notification appliances.
  - 8. Magnetic door holders.
  - 9. Fire Alarm Annunciator Panel (FAAP).
  - 10. Addressable interface device.
  - 11. Digital alarm communicator transmitter.
  - 12. Network communications.
  - 13. System printer.
  - 14. Device Guards.

#### 1.2 definitions

- A. EMT: Electrical Metallic Tubing.
- B. FACP: Fire Alarm Control Panel.
- C. HLI: High Level Interface.
- D. NICET: National Institute for Certification in Engineering Technologies.
- E. PC: Personal computer.
- F. VESDA: Very Early Smoke-Detection Apparatus.

#### 1.3 SUBMITTALS

- A. Product Data: For each type of product, including finished options and accessories.
  - 1. Include construction details, material descriptions, dimensions, profiles and finishes.
  - 2. Include rated capacities, operating characteristics, and electrical characteristics.
- B. Shop Drawings: For fire alarm system:

1. Floor plans (minimum 1/8-inch scale) with room names and numbers, showing device locations and interconnecting conduit and wire. Include location of fire/smoke rated or barrier walls.
2. Drawings shall show proposed layout and anchorage of equipment and appurtenances and equipment relationship to other parts of the work, including clearances for maintenance and operation.
3. Scaled detail drawings of FACP and FAAP panel fronts.
4. Wiring diagram for each device. Include connection details to auxiliary equipment.
5. Riser diagram showing devices, equipment, and interconnecting conduit and wire. Indicate points of connection to other equipment such as, damper actuators, kitchen hood fire protection systems, pre-action fire protection systems, clean agent fire protection systems, elevator machine rooms and shafts, electric door locking hardware, fire door releases, magnetic door holders, and other related devices and equipment.
6. Complete narrative of the sequence of operation.
7. Sequence of operation matrix table including a complete line-by-line listing of fire alarm initiating devices, corresponding device address, and input/output matrix.
8. Voltage drop calculations.
9. Battery sizing calculations.
  - a. Visual alarm power supply sizing calculations.
10. Power supply calculations for magnetic door holders, and electric door locking hardware.
11. Wire identification schedule.
12. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this specification and in NFPA 72. All drawings must be stamped and signed by a Professional Engineer registered in New York State, for approval by the Fire Marshal and NYSED.

#### 1.4 CLOSeOUT SUBMITtALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. Include the following:
  1. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
  2. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
  3. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
  4. Riser diagram.

5. Device addresses.
6. Record copy of site-specific software. This software shall also be in an electronic format to allow an alternate Authorized Distributor to add, change, or modify in any way, the existing system data base.
7. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
  - a. Equipment tested.
  - b. Frequency of testing of installed components.
  - c. Frequency of inspection of installed components.
  - d. Requirements and recommendations related to results of maintenance.
  - e. Manufacturer's user training manuals.
8. Manufacturer's required maintenance related to system warranty requirements.
9. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

#### 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire alarm Level III technician.
- C. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.
- D. Manufacturer and equipment supplier shall have a minimum of ten years' prior experience in New York State. Equipment supplier shall have 24-hour parts and labor service available with a maximum 4-hour response time. There shall be a minimum of 2 Independent Authorized Distributors within a 50-mile radius of project. Proprietary equipment shall not be acceptable.

#### 1.6 PROJECT CONDITIONS

- A. Perform a full test of the existing system prior to starting to work. Document any equipment or components not functioning as designed.
- B. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

#### 1.7 SYSTEM ZONING

- A. Alarm Initiating Devices:
  1. Provide a separate, individual zone for each manual pull station, area smoke detector, duct smoke detector, area heat detector, and water flow switch.

- B. Fire Audible and Visual Alarm Strobes:
  - 1. Each floor of the building (above and below grade) shall be a separate, individual zone.
  - 2. Each stairwell shall be a separate, individual zone.
  - 3. Each exterior area shall be a separate individual zone.
- C. Fire Alarm Control zones:
  - 1. Air Handling Fan systems: Provide one (1) shutdown contact for each air handling fan systems. Contacts shall initiate the shutdown of fan system and closing of dampers on associated floor.
  - 2. Provide two (2) open/close contact for each floor's/zone's dampers grouped as a function of being in the supply or return air streams.
  - 3. Provide one (1) recall contact for each elevator control panel to recall elevator to ground floor.
  - 4. Provide one (1) release control contact for all door lock systems.
- D. Initiating and signaling device wiring circuits/loops/channels shall be loaded to no more than 80 percent (80%) capacity to allow for the installation of future devices.

## 1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
- B. Warranty Period: Three years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. All new fire detection and alarm system components shall be of the same manufacturer and must meet all requirements of the contract documents.
- B. Acceptable manufacturers:
  - 1. Edwards EST
- C. Products for this project shall be of the latest design that has been in service for at least two (2) years, and no more than 4 years. Obsolete or discontinued models are not acceptable.

### 2.2 DESCRIPTION

- A. Fire alarm System shall be EST EST4 voice system.
- B. Fire alarm system infrastructure including conduit, wiring, backboxes, etc. and all associated labor and installation is in the scope of this contract.
- C. Shop drawings and submittal review/approval, testing and programming, project management and closeout documentation shall be by the fire alarm system manufacturer's authorized representative.
- D. Provide a microprocessor-controlled, electrically supervised fire alarm system in accordance with the Contract Documents. Provide detailed system design, all equipment, tools, drawings, labor, materials, accessories, and approvals from governing agencies required to furnish, install, start up, and test a complete operating fire alarm system. Systems shall be provided and placed into operation in accordance with the requirements of the Authority Having Jurisdiction (AHJ).
- E. Labor, materials including conduit and wiring, and accessories not specifically called for in the Contract Documents but required to provide complete, operating, and approved systems, shall be provided within the scope of this contract.
- F. Determine, coordinate, and incorporate the design and construction requirements of the architectural, structural, fire protection and mechanical systems, and auxiliary systems including food service, fire doors and windows, elevators, and other related systems, to fully meet all code requirements.
- G. The fire alarm system manufacturer and Contractor shall provide all required documentation, obtain all required permits and approvals, and shall provide all devices and accessories in the quantities and locations necessary for a fully functional and code-compliant system.
- H. Programming of system shall be based on final room names and numbers, which may not necessarily be the same as those used on the construction documents.
- I. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice/strobe evacuation.
- J. The Fire Alarm Control Panel (FACP) and Fire Alarm Annunciator Panel (FAAP) shall be connected in a network configuration to become components for a distributed intelligence system.
- K. The fire detection and alarm system shall be the fully addressable type. Each fire alarm initiating device shall be a separate, individual zone. Provide interface modules to connect non-addressable devices to addressable wiring channels.
- L. All components provided shall be listed for use with the selected system.

- M. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

## 2.3 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire alarm signal initiation shall be by one or more of the following devices and systems:
  - 1. Manual pull stations.
  - 2. Heat detectors.
  - 3. Smoke detectors.
  - 4. Duct smoke detectors.
  - 5. Waterflow Switch.
- B. Fire alarm signal shall initiate the following actions:
  - 1. Continuously operate alarm notification appliances, including voice evacuation notices.
  - 2. Identify alarm and specific initiating device at FACP, connected network control panels, off-premises network control panels, and remote annunciators.
  - 3. Indicate device in alarm on the graphic annunciator.
  - 4. Transmit an alarm signal to the remote alarm receiving station.
  - 5. Unlock electric door locks in designated egress paths.
  - 6. Release fire and smoke doors held open by magnetic door holders.
  - 7. Activate voice/alarm communication system.
  - 8. Switch heating, ventilating, and air-conditioning equipment controls to fire alarm mode.
  - 9. Close smoke dampers in air ducts of designated air conditioning duct systems.
  - 10. Activate emergency shutoffs for gas and fuel supplies.
  - 11. Record events in the system memory.
- C. Detection of carbon monoxide by a carbon monoxide detector shall:
  - 1. Activate a distinct carbon monoxide alarm at the FACP.
    - a. Carbon monoxide signal shall be a separate and distinct signal from the fire alarm system.
  - 2. Activate distinct local carbon monoxide visual/audible notification appliances for associated carbon monoxide detector in alarm condition.
  - 3. Activate carbon monoxide detector sounder base (if present).
  - 4. Send a distinct carbon monoxide detector supervisory signal to central office.
- D. Supervisory signal initiation shall be by one or more of the following devices and actions:
  - 1. Independent fire detection and suppression systems.
  - 2. User disabling of zones or individual devices.

3. Loss of communication with any panel on the network.
- E. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
  2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
  3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
  4. Loss of primary power at FACP.
  5. Ground or a single break in internal circuits of FACP.
  6. Abnormal AC voltage at FACP.
  7. Break in standby battery circuitry.
  8. Failure of battery charging.
  9. Abnormal position of any switch at FACP or annunciator.
  10. Voice signal amplifier failure.
- F. System Supervisory Signal Actions:
1. Identify specific device initiating the event at FACP, off-premises network control panels, and remote annunciators.
  2. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
  3. Display system status on FAAP.

## 2.4 FIRE ALARM CONTROL Panel (FACP)

- A. General Requirements for FACP:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
    - a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
    - b. Include a real-time clock for time annotation of events on the event recorder and printer.
    - c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
    - d. The FACP shall be listed for connection to a central station signaling system service.
    - e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.

2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
  3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.
- B. Alphanumeric Display and System Controls: Arranged for interface between human operator at FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: Liquid-crystal type, three line(s) of 80 characters, minimum.
  2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.
- C. Initiating Device, Notification Appliance, and Signaling Line Circuits:
1. Pathway Class Designations: NFPA 72, Class B.
  2. Pathway Survivability: Level 0. Staged evacuation Level 2 or 3.
  3. Install no more than 100 addressable devices on each signaling-line circuit.
  4. Serial Interfaces:
    - a. One dedicated RS 485 port for remote station operation using point ID DACT.
    - b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
    - c. One USB or RS 232 port for PC configuration.
    - d. One RS 232 port for VESDA HLI connection.
    - e. One RS 232 port for voice evacuation interface.
- D. Smoke Alarm Verification:
1. Smoke alarm verification shall not be enabled.
- E. Elevator recall shall be initiated only by one of the following alarm-initiating devices:
1. Elevator lobby detectors except the lobby detector on the designated floor.
  2. Smoke detector in elevator machine room.
  3. Smoke detectors in elevator hoistway.
  4. Waterflow switch activation.
  5. Elevator controller shall be programmed to move the cars to the alternate recall floor if lobby detectors located on the designated recall floors are activated.
  6. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.
  7. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.



- F. Notification Appliance Circuit:
  - 1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
  - 2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
  - 3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
- G. Door Controls:
  - 1. Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire alarm system.
- H. Remote Smoke-Detector Sensitivity Adjustment:
  - 1. Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.
- I. Transmission to Remote Alarm Receiving Station:
  - 1. Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.
- J. Voice/Alarm Signaling Service: Central emergency communication system with redundant preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.
  - 1. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711.
    - a. System shall provide a minimum of 8 digital audio channels.
    - b. Allow the application of, and evacuation signal to, indicated number of zones and, at the same time, allow voice paging to the other zones selectively or in any combination.
    - c. Programmable tone and message sequence selection.
    - d. Standard digitally recorded messages for "Evacuation" and "All Clear."
    - e. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of fire-alarm control unit.
  - 2. Status Annunciator: Indicate the status of various voice/alarm speaker zones and the status of firefighters two-way telephone communications zones.

3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.
  4. Primary Power: 24V DC obtained from 120V AC service and a power supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals supervisory and digital alarm communicator transmitters and digital alarm radio transmitters shall be powered by 24V DC source.
  5. Alarm current draw of entire fire alarm system shall not exceed 80 percent of the power-supply module rating.
- K. Primary Power: 24-V dc obtained from 120-V ac service and a power supply module. Initiating device, notification appliances, signaling lines, trouble signals, supervisor signals, supervisory and digital alarm communicator transmitters and digital alarm radio transmitters shall be powered by 24- V dc source.
- L. Secondary Power: Provide sufficient battery capacity to operate the entire system upon loss of power as required by NFPA 72 Section 10.6.7.2.1. Battery capacity shall be calculated for minimum 24 hours of capacity in nonalarm (standby) mode and then 15 minutes at maximum connected load after that time period for audio voice systems and 24/5 for non-audio systems. The on-site emergency power system shall not be used when sizing the battery supply. The system shall automatically transfer to the standby batteries upon power failure. Battery charging and recharging shall be automatic.
- 2.5 MANUAL FIRE ALARM PULL STATIONS (EST siga-270 SERIES)
- A. General Requirements: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACP.
  2. Station Reset: Key-operated switch.
- 2.6 SYSTEM SMOKE DETECTORS (EST SIGA-PD)
- A. General Requirements:
1. Comply with UL 268 and FM approved; operating at 24V DC, nominal, Photoelectric type.
  2. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
  3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

4. Integral Visual-Indicating Light: LED type, indicating detector alarm/power-on status.
  5. Thirty (30) mesh insect screen and magnetically activated test.
  6. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at FACP for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by FACP.
    - a. Rate-of-rise temperature characteristic of combination smoke- and heat-detection units shall be selectable at FACP for 15 or 20 deg F per minute.
    - b. Multiple levels of detection sensitivity for each sensor.
- B. Photoelectric Smoke Detectors:
1. Detector address shall be accessible from FACP and shall be able to identify the detector's location within the system and its sensitivity setting.
  2. An operator at FACP, having the designated access level, shall be able to manually access the following for each detector:
    - a. Primary status.
    - b. Device type.
    - c. Present average value.
    - d. Present sensitivity selected.
    - e. Sensor range (normal, dirty, etc.).
- C. Duct Smoke Detectors: Photoelectric type complying with UL 268A, 24V DC. (EST SIGA-SD)
1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
  2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
    3. Primary status.
    4. Device type.
    5. Present average value.
    6. Present sensitivity selected.
    7. Sensor range (normal, dirty, etc.).
  8. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
  9. Duct detector and housing shall be calibrated and adjusted for sensitivity at the manufacturer's factor to U.L. standards. Detector and housing shall be self-compensating for the effect of air velocity, temperature, humidity and atmospheric pressure.
  10. Each duct detector shall be provided with sampling tubes sized according to duct size, air velocity, and installation conditions.
  11. Each duct detector shall be provided with remote alarm LED on a single gang plate, surface or flush mounted.

## 2.7 CARBON MONOXIDE DETECTORS (est siga-cod)

- A. General: Carbon monoxide detector listed for connection to fire-alarm system.
  - 1. Mounting: Adapter plate for outlet box mounting.
  - 2. Testable by introducing test carbon monoxide into the sensing cell.
  - 3. Detector shall provide alarm contacts and trouble contacts.
  - 4. Detector shall send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
  - 5. Comply with UL 2075.
  - 6. Locate, mount, and wire according to manufacturer's written instructions.
  - 7. Provide means for addressable connection to fire-alarm system.
  - 8. Detector base shall provide a temporal 4 alarm signal.

## 2.8 HEAT DETECTORS (EST SIGA-HRD)

- A. General Requirements for Heat Detectors: Comply with UL 521.
  - 1. Temperature sensors shall test for and communicate the sensitivity range of the device.
- B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
  - 1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
  - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP.

## 2.9 BEAM smoke detector (EST 5000 SERIES)

- A. Shall be photoelectric, four-wire, 24 VDC transmitter and receiver (beam type) smoke detector and shall be field adjustable to U.L. Standards for sensitivity (20, 30, 40, 50, 60 and 70% beam obscuration).
- B. The transmitter unit shall utilize a solid-state infrared (IR), crystal locked beam source which shall enable the receiver unit to distinguish the detection beam from all types of EFI, including fluorescent, mercury and sodium lighting.
- C. The detector receiver shall provide automatic digital compensation circuitry to adjust for dust accumulation, component aging and temperature changes and also be able to discriminate between smoke obscuration and beam interruption.
- D. The detector shall utilize solid-state components for long life reliability and provide a range of from thirty feet (30') to three hundred fifty feet (350') with the beam transmitter and receiver optics being adjustable  $\pm 90^\circ$  in the horizontal plane and  $\pm 10^\circ$  in the vertical plane.

- E. Detectors shall be listed for U.L. Standard 268.
- F. Detector Address: Accessible from fire-alarm control unit and able to identify the detector's location within the system and its sensitivity setting.
- G. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
  - 1. Primary status.
  - 2. Device type.
  - 3. Present average value.
  - 4. Present sensitivity selected.
  - 5. Sensor range (normal, dirty, etc.).

## 2.10 NOTIFICATION APPLIANCES (EST genesis series)

- A. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
  - 1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.
- C. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch high letters on the lens.
  - 1. Rated Light Output:
    - a. 15/30/75/110 cd, selectable in the field.
  - 2. Mounting: Wall mounted unless otherwise indicated.
  - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
  - 4. Flashing shall be in a temporal pattern, synchronized with other units.
  - 5. Strobe Leads: Factory connected to screw terminals.
  - 6. Mounting Faceplate: Factory finished, red.
- D. Voice/Tone Notification Appliances:
  - 1. Speakers shall be EST High Fidelity capable of providing 520hz.
  - 2. Comply with UL 1480.

3. Speakers for Voice Notification: Locate speakers for voice notification to provide the intelligibility requirements of the "Notification Appliances" and "Emergency Communications Systems" chapters of NFPA 72.
  4. Speaker shall be capable of field selection of speaker voltage (25 and 70.7 Vrms) and power settings (1/4 W, 1/2 W, 1 W, 2 W).
    - a. Final settings shall be field adjusted to match the acoustical environment of each speaker.
- E. Exit Marking Audible Notification Appliance:
1. Exit marking audible notification appliances shall meet the audibility requirements in NFPA 72.
  2. Provide exit marking audible notification appliances at the entrance to all building exits.
  3. Provide exit marking audible notification appliances at the entrance to areas of refuge with audible signals distinct from those used for building exit marking.
- 2.11 MAGNETIC door holders. (Edwards 1500 series)
- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching doorplate.
1. Electromagnets: Require no more than 3 W to develop 35-lbf of holding force.
  2. Wall-Mounted Units: Flush mounted unless otherwise indicated.
  3. Rating: 24-V dc.
- B. Material and Finish: Brushed aluminum.
- 2.12 Fire alarm ANNUNCIATOR panel (FAAP)
- A. Graphic Annunciator Panel: Mounted in an aluminum frame with nonglare, minimum 3/16-inch thick, clear acrylic cover over graphic representation of the facility. Detector locations shall be represented by red LED lamps. Normal system operation shall be indicated by a lighted, green LED. Trouble and supervisory alarms shall be represented by an amber LED.
1. Comply with UL 864.
  2. Shall Operate from 24-V dc power supplied by the FACP.
  3. Include built-in voltage regulation, reverse polarity protection, RS 232/422 serial communications, and a lamp test switch.
  4. Surface mounted in a NEMA 250, Type 1 cabinet, with key lock and no exposed screws or hinges.
  5. Graphic representation of the facility floorplan, and each detector shall be represented by an LED in its actual location. Floorplan shall be at 1/8-inch per foot scale or larger.
  6. The LED representing a detector shall flash two times per second while detector is an alarm.

a. ADDRESSABLE INTERFACE DEVICE

- B. General:
1. Include address-setting means on the module.
  2. Store an internal identifying code for control panel use to identify the module type.
  3. Listed for controlling HVAC fan motor controllers.
  4. Devices shall be flush mounted in finished areas and surface mounted with back box in unfinished areas.
- C. Monitor Module (SIGA-CT series): Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts using NFPA 72A Style B (Class B, Two-Wire) circuit supervision. Module responds to polling signals from FACP/Transponder and shall report alarm initiating/supervisory circuit status changes to it.
- D. Control Module (EST SIGA-CRH): Microelectronic module with one (1) individual addressable control relay with double-pole/double-throw (DPDT) contacts rated at two (7.0A) @ 120VAC/28VDC. Module response to control signals from FACP/Transponder.

2.13 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from FACP and automatically capture two telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.
- C. Addressable communications circuits from system transponders shall be electrically supervised in accordance with NFPA 72A Style 6 (Class A, four-wire) standards, monitoring for alarm (shorts), trouble (opens), and ground faults. When wired in the Style 6 (Class A, four-wire) configuration, a single open or ground fault shall not prevent the receipt of an alarm condition. Addressable communications circuits shall utilize two (2) cables of two (2) No. 18 AWG twisted conductors from the transponder to the connected addressable devices.
- D. Local functions and display at the digital alarm communicator transmitter shall include the following:
1. Verification that both telephone lines are available.

2. Programming device.
  3. LED display.
  4. Manual test report function and manual transmission clear indication.
  5. Communications failure with the central station or FACP.
- E. Digital data transmission shall include the following:
1. Address of the alarm-initiating device.
  2. Address of the supervisory signal.
  3. Address of the trouble-initiating device.
  4. Loss of ac supply.
  5. Loss of power.
  6. Low battery.
  7. Abnormal test signal.
  8. Communication bus failure.
- F. Secondary Power: Integral rechargeable battery and automatic charger.
- G. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

## 2.14 NETWORK COMMUNICATIONS

- A. Provide network communications for fire alarm system according to fire alarm manufacturer's written requirements.
- B. Provide network communications pathway per manufacturer's written requirements and requirements in NFPA 72 and NFPA 70.
- C. Provide integration gateway using BACnet for connection to building automation system when required.

## 2.15 system printer. (EST PTIS)

- A. General: Provide a dot-matrix type, listed and labeled as an integral part of the fire alarm system.

## 2.16 DEVICE GUARDS

- A. Description: Welded wire mesh of size and shape for the device requiring protection.
  1. Factory fabricated and furnished by device manufacturer.
  2. Finish: Paint of color to match the protected device.
  3. Guards must be UL cross listed with devices being used.

## PART 3 EXECUTION



### 3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
  - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
  - 1. Devices placed in service before all other trades have completed cleanup shall be replaced.
  - 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.
- C. Manual Fire Alarm Pull Stations:
  - 1. Install manual fire alarm pull station in the normal path of egress within 60 inches of the exit doorway.
- D. Smoke or Heat Detector Spacing:
  - 1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
  - 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
  - 3. Smooth ceiling spacing shall not exceed 30 feet.
  - 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A or Annex B in NFPA 72.
  - 5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.

6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
- E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- F. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- G. Audible Alarm Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- H. Visible Alarm-Indicating Devices: Install adjacent to each alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.
- I. Device Location-Indicating Lights: Locate in public space near the device they monitor.

### 3.3 PATHWAYS

- A. Fire alarm pathway and circuit wiring installation shall comply with NEC Article 760.
- B. Where exposed, all fire alarm circuits shall be installed in dedicated EMT conduit.
- C. Where existing wall devices are being replaced in the same location, install new fire alarm circuit wiring in existing conduit within wall (where available).
- D. Pathways above recessed ceilings and in nonaccessible locations may be plenum-rated cable.
- E. All pathways must be independently supported from the structure above.
- F. Where passing through a wall or floor, provide a metal raceway or rigid nonmetallic conduit sleeve.
- G. All penetrations of rated walls and floors shall be properly fire-stopped.

### 3.4 IDENTIFICATION

- A. Provide an identification nameplate for each equipment cabinet. Nameplates shall correspond with labeling identified in the submittal drawings.
- B. Fire alarm conduit shall be permanently labeled "FIRE ALARM" every 30 feet.
- C. Fire alarm junction boxes shall be painted red.

- D. All initiating and indicating devices shall be labeled with self-adhesive tape with black lettering and identification labeling according to circuit loop and device address/number.
- E. Color code all wiring per recommended standards. Tag all wires in terminal cabinets with tie wrap tags with inked identification.
- F. Install framed instructions in a location visible from FACP.

### 3.5 GROUNDING

- A. Ground FACP and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to FACP.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

### 3.6 testing

- A. The fire alarm system manufacturer or manufacturer's authorized representative shall test and inspect components, assemblies, and equipment installations, including connections.
- B. Tests shall be witnessed by District (Owner), Engineer of Record, and the Fire Department.
- C. The following tests and inspections shall be performed:
  - 1. Visual Inspection: Conduct visual inspection prior to testing.
    - a. Inspection shall be based on completed record Drawings and system documentation that is required by NFPA 72.
    - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
  - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
  - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
  - 4. Test visible appliances for the public operating mode according to manufacturer's written instructions.
  - 5. System manufacturer shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

- D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- E. Fire alarm system will be considered defective if it does not pass tests and inspections.

3.7 closeout documentation

- A. The fire alarm system manufacturer or manufacturer's authorized representative shall prepare and submit to the Engineer of Record all NFPA 72 required closeout documentation including, but not limited to:
  - 1. System Record of Completion
  - 2. Notification Appliance Power Panel Supplementary Record of Completion
  - 3. System Record of Inspection and Testing
  - 4. Notification Appliance Supplementary Record of Inspection and Testing
  - 5. Initiating Device Supplementary Record of Inspection and Testing
  - 6. Periodic Inspection, Testing and Maintenance Documentation
- B. Record Drawings, to include:
  - 1. Minimum 1/8" scale floorplan drawings indicating all final device types, locations, ratings, settings and addresses
  - 2. Wiring diagram of each device type
  - 3. Riser diagram showing devices, device addresses, equipment, and interconnecting conduit and wire
  - 4. Narrative of sequence of operation
  - 5. Sequence of operation matrix (includes complete line-by-line listing for fire alarm initiating devices, device address and input/output matrix)
  - 6. Voltage drop calculations
  - 7. Battery sizing calculations
  - 8. Visual alarm power supply sizing calculations
  - 9. Power supply calculations for door holders
  - 10. Wire identification schedule
  - 11. Legend
- C. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
- D. Operating instructions for mounting at fire-alarm control unit and each annunciator unit.
- E. Warranty documentation.
- F. All closeout documentation shall be signed and sealed by a Registered Professional Engineer in New York State.

3.8 maintenance service

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
  - 1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
  - 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- B. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire alarm system.

END OF SECTION

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## SECTION 312000 - EXCAVATION AND FILL

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes:
  - 1. Preparing subgrades for structures, walks, pavements, grasses and plants.
  - 2. Subbase course for concrete slabs, walks and asphalt pavement.
  - 3. Excavating and backfilling trenches for utilities and structures.

#### 1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 31 23 16: Rock Removal
- C. Section 32 91 20: Topsoil
- D. Section 32 92 19: Seeding

#### 1.3 DEFINITIONS

- A. Earth Excavation: The removal of all surface and subsurface material not classified as rock as defined below.
- B. Unsatisfactory Soil: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction. Soil that may contain rock or gravel larger than 3 inches in any dimension, frozen materials, organic matter, vegetation, soft, nondurable particles, elongated particles or other deleterious matters.
- C. Contaminated Soil: Soil that may require specific disposal method/location as it may contain items such as but not limited to trace/detect chemical, oil or soft or loose bituminous asphalt tar.
- D. Construction Debris Soil: Soil containing debris, waste, rubbish, slag, cinders, ashes, metals, or other manmade or foreign materials.

- E. Rock: Limestone, sandstone, shale, granite, and similar material in solid beds or masses in its original or stratified position which can be removed only by blasting operations, drilling, wedging, or use of pneumatic tools, and boulders with a volume greater than 1.0 cu yd. Concrete building foundations and concrete slabs, not indicated, with a volume greater than 1.0 cu yd shall be classified as rock.
  - 1. Limestone, sandstone, shale, granite, and similar material in a broken or weathered condition which can be removed with an excavator or backhoe equipped with a bucket with ripping teeth or any other style bucket shall be classified as earth excavation.
  - 2. Masonry building foundations, whether indicated or not, shall be classified
  - 3. as earth excavation.
- F. Unclassified Earth Excavation: The excavation and disposal of all surface and subsurface materials of any description necessary to perform the work of this contract. This will include:
  - 1. All soil deposits of any description both above and below groundwater levels. These may be naturally deposited or placed by previous construction operations.
- G. Subgrade Surface: Surface upon which subbase or topsoil is placed.
- H. Subbase: Select granular material or subbase course Type 2 which is placed immediately beneath pavement or concrete slabs.
- I. Maximum Density: The dry unit weight in pounds per cubic foot of the soil at "Optimum Moisture Content" when determined by ASTM D 698 (Standard Proctor), or ASTM D 1557 (Modified Proctor).
- J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- K. Landscaped Areas: Areas not covered by structures, walks, roads, paving, or parking.
- L. Unauthorized Excavation: The removal of material below required elevation indicated on the Drawings or beyond lateral dimensions indicated or specified without specific written direction by the Engineer.
- M. Grading Limit Line (Shown on Drawings): Limits of grading, excavations and filling required for the work of this contract. Unless specifically noted otherwise, the Grading Limit Line and Contract Limit Line will be considered the same.

#### 1.4 SUBMITTALS

- A. Product Data:
  - 1. Filter Fabric: Manufacturer's catalog sheets, specifications, and installation instructions.



2. Geogrid: Manufacturer's catalog sheets, specifications, and installation instructions.

B. Quality Control Submittals:

1. Subbase Materials: Material Test Reports: Classification according to ASTM D 2487, laboratory compaction curve according to ASTM D 1557 and certified gradation analysis according to ASTM C136 for each soil material proposed for fill and backfill. Name and location of source and the DOT Source Number.
2. Other Aggregates: Name and location of source and soil laboratory test results.

1.5 PROJECT CONDITIONS/COORDINATION AND SCHEDULING

A. Existing Utilities:

1. Coordinate the work to determine the extent of the areas of subsurface investigation required to locate all underground utilities and service connections in the areas of excavation.
2. Coordinate the work with the Owner and Engineer to minimize utility disruptions and facility operations. Provide a schedule for the Work required to the Owner and Engineer for approval. Upon approval of the schedule, notify the Owner and Engineer a minimum of three (3) working days prior to performing the Work.
3. Within the areas of excavation, all underground utilities and service connections shall be field located and their locations marked at least two (2) weeks prior to the performance of the required excavation work.

B. Existing Conditions:

1. Protect existing trees and plants during performance of the work unless otherwise indicated. Box trees and plants indicated to remain within the grading limit line with temporary steel fencing or solidly constructed wood barricades as required. Protect root systems from smothering. Do not store excavated material, or allow vehicular traffic or parking within the branch drip line. Restrict foot traffic to prevent excessive compaction of soil over root systems.
2. Dewatering: Include the disposal of surface water and ground water, which may accumulate in open excavations, unfinished fills, or other low areas. Remove water by pumping, or other methods to prevent softening of exposed surfaces. Surface dewatering plan shall include the rerouting of any storm water runoff or natural drainage if necessary and shall comply with NYS DEC requirements.
3. Protection and Restoration of Surfaces: Protect newly graded areas from traffic, erosion, and settlements. Repair and reestablish damaged or eroded slopes, elevations or grades and restore surface construction prior to acceptance. Protect existing streams, ditches and storm drain inlets from water-borne soil by means of straw bale dikes. Conduct work in accordance with NYS DEC requirements.

C. Cold Weather Requirements:

1. Excavation: When freezing temperatures are anticipated, do not excavate to final required elevations for concrete work unless concrete can be placed immediately.

2. Backfilling: Do not backfill with any frozen soil materials.

- D. Thru-traffic or fill placement with heavy construction vehicles or equipment which causes rutting or weaving to occur within the perimeter of a building will not be permitted. If rutting or weaving occurs during placement of fill, place specified fill in a stable area outside building perimeter and spread with tracked equipment to specified layer thickness.

#### 1.6 DELIVERY AND STORAGE

- A. Deliver and store materials in a manner to prevent contamination or segregation.
- B. Protect filter fabric from sunlight during transportation and storage.

#### 1.7 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.
- B. Routine testing of existing soils and compacted material for compliance with these Specifications shall be performed by a testing agency acceptable to Engineer.
- C. Compacted material that does not meet density requirements shall be removed and/or re-compacted, and retested.

### PART 2 PRODUCTS

#### 2.1 MATERIALS

- A. Select Granular Fill Material: Stockpiled, sound, durable, sand, gravel, stone, or blends of these materials, free from organic and other deleterious materials. Comply with the gradation and material requirements specified below:

| SIEVE      |                   | PERCENT PASSING |
|------------|-------------------|-----------------|
| SIEVE SIZE | SIZE OPENING (MM) |                 |
| 2 INCH     | 50.0              | 100             |
| NO. 40     | 0.425             | 0-70            |
| NO. 200    | 0.075             | 0-15            |

1. Magnesium Sulfate Soundness Test: 20 percent maximum loss by weight after four test cycles.
2. Plasticity Index: The plasticity index of the material passing the No. 40 mesh sieve will not exceed 5.0.

3. Elongated Particles: Not more than 30 percent, by weight, of the particles retained on a 1/2-inch sieve will consist of flat or elongated particles. A flat or elongated particle is defined as one which has its greatest dimension more than three times its least dimension.

- B. NYSDOT Subbase Course Type 2: Stockpiled, crushed ledge rock or approved blast furnace slag. Comply with the gradation and material requirements specified below:

| SIEVE      |                   | PERCENT PASSING |
|------------|-------------------|-----------------|
| SIEVE SIZE | SIZE OPENING (MM) |                 |
| 2 INCH     | 50.0              | 100             |
| 1/4 INCH   | 6.3               | 25-60           |
| NO. 40     | 0.425             | 5-40            |
| NO. 200    | 0.075             | 0-10            |

1. Magnesium Sulfate Soundness Test: 20 percent maximum loss by weight after four test cycles.
2. Plasticity Index: The plasticity index of the material passing the No. 40 mesh sieve will not exceed 5.0.
3. Elongated Particles: Not more than 30 percent, by weight, of the particles retained on a 1/2-inch sieve will consist of flat or elongated particles. A flat or elongated particle is defined as one which has its greatest dimension more than three times its least dimension.

- C. NYSDOT #1 Crushed Stone: Clean, durable, sharp-angled fragments of rock of uniform quality. Comply with the gradation and material requirements specified below:

| SIEVE      |                   | PERCENT PASSING |
|------------|-------------------|-----------------|
| SIEVE SIZE | SIZE OPENING (MM) |                 |
| 1 INCH     | 25.0              | 100             |
| 1/2 INCH   | 12.5              | 90 – 100        |
| 1/4 INCH   | 6.3               | 0-15            |

1. Magnesium Sulfate Soundness Test: 18 percent maximum loss by weight after ten test cycles.

- D. NYSDOT #2 Crushed Stone: Clean, durable, sharp-angled fragments of rock of uniform quality. Comply with the gradation and material requirements specified below:

| SIEVE      |                   | PERCENT PASSING |
|------------|-------------------|-----------------|
| SIEVE SIZE | SIZE OPENING (MM) |                 |
| 1-1/2 INCH | 37.5              | 100             |
| 1 INCH     | 25.0              | 90 – 100        |
| 1/2 INCH   | 12.5              | 0-15            |

1. Magnesium Sulfate Soundness Test: 18 percent maximum loss by weight after ten test cycles.

- E. NYSDOT #1 Screened Gravel: Clean, durable gravel free from coatings. Comply with the gradation and material requirements specified below:

| SIEVE      |                   | PERCENT PASSING |
|------------|-------------------|-----------------|
| SIEVE SIZE | SIZE OPENING (MM) |                 |
| 1 INCH     | 25.0              | 100             |
| 1/2 INCH   | 12.5              | 90 – 100        |
| 1/4 INCH   | 6.3               | 0-15            |

1. Magnesium Sulfate Soundness Test: 18 percent maximum loss by weight after ten test cycles.

- F. NYSDOT #2 Screened Gravel: Clean, durable gravel free from coatings. Comply with the gradation and material requirements specified below:

| SIEVE      |                   | PERCENT PASSING |
|------------|-------------------|-----------------|
| SIEVE SIZE | SIZE OPENING (MM) |                 |
| 1-1/2 INCH | 37.5              | 100             |
| 1 INCH     | 25.0              | 90 – 100        |
| 1/2 INCH   | 12.5              | 0-15            |

1. Magnesium Sulfate Soundness Test: 18 percent maximum loss by weight after ten test cycles.

- G. Underdrain Filter Type 2 (NYSDOT 605.10, 733-2002): Material consisting of crushed stone, sand, gravel or screened gravel. Comply with the gradation and material requirements specified below:

| SIEVE      |                   | PERCENT PASSING |
|------------|-------------------|-----------------|
| SIEVE SIZE | SIZE OPENING (MM) |                 |
| 1/2 INCH   | 12.5              | 100             |
| 1/4 INCH   | 6.3               | 20 – 100        |
| NO. 10     | 2.0               | 0-15            |
| NO. 20     | .85               | 0-5             |

1. Magnesium Sulfate Soundness Test: 20 percent maximum loss by weight after ten test cycles.

- H. Selected Borrow/Fill: Sound, durable, sand, gravel, stone, or blends of these materials, free from organic and other deleterious materials. Comply with the gradation requirements specified below:

| SIEVE      |                   | PERCENT PASSING |
|------------|-------------------|-----------------|
| SIEVE SIZE | SIZE OPENING (MM) |                 |

|         |       |      |
|---------|-------|------|
| 4 INCH  | 101.6 | 100  |
| NO. 40  | 0.425 | 0-70 |
| NO. 200 | 0.075 | 0-15 |

- I. Suitable Material (Fill and Backfill for Landscaped Areas): Material consisting of mineral soil (inorganic), blasted or broken rock and similar materials of natural or man-made origin, including mixtures thereof. Maximum particle size will not exceed 2/3 of the specified layer thickness prior to compaction. NOTE: Material containing cinders, industrial waste, sludge, building rubble, land fill, muck, and peat will be considered unsuitable for fill and backfill, except topsoil and organic silt may be used as suitable material in landscaped areas provided it is placed in the top layer of the subgrade surface.
- J. Flowable Fill: Shall consist of a mixture of Portland cement, sand, water and admixtures proportioned to provide a non-segregating, free-flowing, self-consolidating material that will result in a hardened, dense backfill.
  1. Shall have a 28-day compressive strength between 40 and 100 psi.

## 2.2 GEOTECHNICAL FABRIC

- A. Filter Fabric (GeoTextile):
  1. Pavement Section Geogrid: Tensar TriAx Geogrid or approved equivalent.
  2. Erosion Control: Filter X, Mirafi 100X, Stabilinka T140N or approved equivalent.
  3. Separation for Underdrains: Amoco 2002 & 2004, Contech Construction Products Inc. C-180, Synthetic Industries Geotex 250ST & 315ST, Mirafi Geolon HP570 & HP1500 or approved equivalent.
  4. ADS Geosynthetics 315WTM woven geotextile fabric.
  5. ADS Geosynthetics 601T non-woven geotextile fabric.

## PART 3 EXECUTION

### PREPARATION

- 4.1 Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth moving operations.
- 4.2 Protect and maintain erosion and sedimentation controls during earth moving operations.
- 4.3 CLEARING AND GRUBBING

- 4.4 Clear and grub the site within the grading limit line of trees, shrubs, brush, other prominent vegetation, debris, and obstructions except for those items indicated to remain. Completely remove stumps and roots protruding through the ground surface.
  - A. Use only hand methods for grubbing inside the drip line of trees indicated to be left standing.
  - B. Where roots and branches of trees indicated to be saved interfere with new construction, carefully and cleanly cut them back to point of branching.
- 4.5 Fill depressions caused by the clearing and grubbing operations in accordance with the requirements for filling and backfilling, unless further excavation is indicated.
- 4.6 REMOVAL OF TOPSOIL
- 4.7 Remove existing topsoil from areas within the Grading Limit Line where excavation or fill is required.
- 4.8 Stockpile approved topsoil where directed until required for use. Place, grade, and shape stockpiles for proper drainage.
  - A. Topsoil will be tested prior to stockpiling. Stockpile only quantities of topsoil approved in writing for re-use.
- 4.9 UNDERGROUND UTILITIES
- 4.10 Locate existing underground utilities prior to commencing excavation work. Determine exact utility locations by hand excavated test pits. Support and protect utilities to remain in place.
- 4.11 Do not interrupt existing utilities that are in service until temporary or new utilities are installed and operational.
- 4.12 Utilities to remain in service: Will be re-routed as shown on the Contract Drawings.
- 4.13 Utilities abandoned beneath and five feet laterally beyond the structure's proposed footprint will be removed in their entirety. Excavations required for their removal will be backfilled and compacted as specified herein.
- 4.14 Utilities extending outside the five feet limit specified above may be abandoned in place provided their ends are adequately plugged as described below.

- A. Permanently close open ends of abandoned underground utilities exposed by excavations, which extend outside the limits of the area to be excavated.
- B. Close open ends of metallic conduit and pipe with threaded galvanized metal caps or plastic plugs or other approved method for the type of material and size of pipe. Do not use wood plugs.
- C. Close open ends of concrete and masonry utilities with concrete or flow-able fill.

#### 4.15 EXCAVATION

4.16 Excavate earth as required for the Work.

4.17 Install and maintain all erosion and sedimentation controls during all earthwork operations as specified on the Contract Drawings.

4.18 Maintain sides and slopes of excavations in a safe condition until completion of backfilling. Comply with Code of Federal Regulations Title 29 - Labor, Part 1926 (OSHA).

- A. Trenches: Deposit excavated material on one side of trench only. Trim banks of excavated material to prevent cave-ins and prevent material from falling or sliding into trench. Keep a clear footway between excavated material and trench edge. Maintain areas to allow free drainage of surface water.

4.19 Stockpile excavated materials classified as suitable material where directed, until required for fill. Place, grade, and shape stockpiles for proper drainage as approved by the Engineer.

4.20 Excavation for Structures: Conform to elevations, lines, and limits indicated. Excavate to a vertical tolerance of plus or minus 1 inch. Extend excavation a sufficient lateral distance to provide clearance to execute the work.

4.21 Slabs and Floors: Excavate to the following depths below bottom of concrete for addition of select granular material:

- A. Interior Floors: 6 inches unless otherwise indicated.
- B. Exterior Slabs and Steps: 12 inches unless otherwise indicated.

- 4.22 Pipe Trenches: Open only enough trench length to facilitate laying pipe sections. Unless otherwise indicated on the Drawings, excavate trenches approximately 24 inches wide plus the outside pipe diameter, equally divided on each side of pipe centerline. Cut trenches to cross section, elevation, profile, line, and grade indicated. Accurately grade and shape trench bottom for uniform bearing of pipe in undisturbed earth. Excavate at bell and coupling joints to allow ample room for proper pipe connections.
- A. Trench in Rock: Excavate an additional 6 inches below bottom of pipe for bed of cushion material under the piping.
- 4.23 Open Ditches: Cut ditches to cross sections and grades indicated.
- 4.24 Pavement: Excavate to subgrade surface elevation.
- 4.25 Unauthorized Excavations: Unless otherwise directed, backfill unauthorized excavation under footings, foundation bases, and retaining walls with compacted select granular material without altering the required footing elevation. Elsewhere, backfill and compact unauthorized excavation as specified for authorized excavation of the same classification, unless otherwise directed by the Engineer.
- 4.26 Notify the Engineer upon completion of excavation operations. Do not proceed with the work until the excavation is inspected and approved. Inspection of the excavation by the Engineer will be made on three working days notice.
- 4.27 Removal of Unsuitable Material Beneath Structures and Other Improvements: Excavate encountered unsuitable materials, which extend below required elevations, to additional depth as directed by the Engineer. Have cross sections taken to determine the quantity of such excavation. Do not backfill this excavation prior to quantity measurement.
- 4.28 DEWATERING
- 4.29 Prior to the performance of any excavations provide dewatering methods such that the groundwater table is maintained at an elevation that is beneath the excavated depth.
- 4.30 Prevent surface and subsurface water from flowing into excavations and trenches and from flooding the site and surrounding area.



- 4.31 Do not allow water to accumulate in excavations or trenches. Remove water from all excavations immediately to prevent softening of undercutting footings, and soil changes detrimental to the stability of subgrades. Furnish and maintain pumps, sumps, suction and discharge piping systems, and other system components necessary to convey the water away from the Site.
- 4.32 Convey water removed from excavations, and rain water, to collecting or run-off area. Cut and maintain temporary drainage ditches and provide other necessary diversions outside excavation limits for each structure. Do not use trench excavations as temporary drainage ditches.
- 4.33 Provide temporary controls to restrict the velocity of discharged water as necessary to prevent erosion and siltation of receiving areas.
- 4.34 SUBGRADE SURFACE FOR WALKS AND PAVEMENT
- 4.35 Shape and grade subgrade surface as follows:
  - A. Walks: Shape the surface of areas under walks to required line, grade and cross section, with the finish surface not more than 1 inch above or below the required subgrade surface elevation.
  - B. Pavements: Shape the surface of areas under pavement to required line, grade and cross section, with the finish surface not more than 1/2 inch above or below the required subgrade surface elevation.
- 4.36 Grade Control: During construction, maintain lines and grades including crown and cross-slope of subbase course.
- 4.37 Thoroughly compact subgrade surface for walks and pavement by mechanical rolling, tamping, or with vibratory equipment as approved to the density specified.
- 4.38 PLACING GEOTECH FABRIC
- 4.39 Place and overlap geotech fabric in accordance with the manufacturer's installation instructions, unless otherwise shown.
- 4.40 Cover tears and other damaged areas with additional fabric layer extending three feet beyond the damage.
- 4.41 Do not permit traffic or construction equipment directly on fabric.

- 4.42 Backfill over fabric within two weeks after placement. Backfill in accordance with the fabric manufacturer's instructions and in a manner to prevent damage to the fabric.
- 4.43 PLACING FILL AND BACKFILL
- 4.44 Surface Preparation of Fill Areas: Strip topsoil, remaining vegetation, and other deleterious materials prior to placement of fill. Remove all asphalt pavement in its entirety from areas requiring the placement of fill or break up old pavements to a maximum size of four inches. Prior to placement of fill, smooth out and compact areas where wheel rutting has occurred due to stripping or earthwork operations.
- 4.45 Place backfill and fill materials in layers not more than eight inches thick in loose depth unless otherwise specified. Before compaction, moisten or aerate each layer as necessary to facilitate compaction to the required density. Do not place backfill or fill material on surfaces that are muddy, frozen, or covered with ice.
- A. Place fill and backfill against foundation walls, and in confined areas such as trenches not easily accessible by larger compaction equipment, in maximum six inch thick loose depth layers.
  - B. For large fill areas, the layer thickness may be modified by the Engineer, at the Contractor's written request, if in the Engineer's judgment, the equipment used is capable of compacting the fill material in a greater layer thickness. This request will include the type and specifications of compaction equipment intended for use.
- 4.46 Under Exterior Concrete Slabs and Steps:
- A. Up to Subgrade Surface Elevation: Place selected fill when fill or backfill is required.
  - B. Subbase Material: Place 12 inches of select granular material over subgrade surface.
- 4.47 Under Pavements and Walks:
- A. Up to Subgrade Surface Elevation: Place selected fill when fill or backfill is required.
  - B. Subbase Material: Place as indicated.
- 4.48 Landscaped Areas: Place suitable material when required to complete fill or backfill areas up to subgrade surface elevation. Do not use material containing rocks over four inches in diameter within the top 12 inches of suitable material.

- 4.49 Plastic Pipe in Trenches: Place cushion material a minimum of six inches deep under pipe, 12 inches on both sides, and 12 inches above top of pipe. Complete balance of backfill as specified.
- A. Trench in Rock: Place a minimum six-inch-deep bed of cushion material under pipe.
- 4.50 Backfilling Excavation Resulting From Removal of Unsuitable Material Beneath Structures and Other Improvements: Backfill the excavation with compacted select granular material.
- 4.51 COMPACTION
- 4.52 All materials with exception of open graded stone:
- A. Compact each layer of fill and backfill for the following area classifications to the percentage of maximum density specified below and at a moisture content suitable to obtain the required densities, but at not less than three percent drier or more than two percent wetter than the optimum content as determined by ASTM D 698 (Standard Proctor) or 1557 (Modified Proctor).
1. Structures (entire area within ten feet outside perimeter): 95 percent.
  2. Concrete Slabs and Steps: 95 percent.
  3. Landscaped Areas: 90 percent.
  4. Pavements and Walks: 95 percent.
  5. Pipes and Tunnels: 95 percent.
  6. Pipe Bedding: 95 percent.
- B. When the existing ground surface to be compacted has a density less than that specified for the particular area classification, break up and pulverize, and moisture condition to facilitate compaction to the required percentage of maximum density.
- C. Moisture Control:
1. Where fill or backfill must be moisture conditioned before compaction, uniformly apply water to the surface and to each layer of fill or backfill. Prevent ponding or other free water on surface subsequent to, and during compaction operations.
  2. Remove and replace, or scarify and air dry, soil that is too wet to permit compaction to specified density. Soil that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing, until moisture content is reduced to a value which will permit compaction to the percentage of maximum density specified.

- D. If a compacted layer fails to meet the specified percentage of maximum density, the layer will be recompact and retested. If compaction cannot be achieved the material/layer will be removed and replaced. No additional material may be placed over a compacted layer until the specified density is achieved.

#### 4.53 ROUGH GRADING

4.54 Exterior Grading: Trim and grade area within the grading limit line and excavations outside the limit line, required by this Contract, to a level of 4 inches below the finish grades indicated unless otherwise specified herein or where greater depths are indicated. Provide smooth uniform transition to adjacent areas.

- A. Slope cut and fill in transition areas, outside of the grading limit line, to meet corresponding levels of existing grades at a slope of 1 vertical to 2 horizontal unless otherwise indicated.
- B. Landscaped Areas: Provide uniform subgrade surface within 1 inch of required level to receive topsoil thickness specified. Compact fill as specified to within three inches of subgrade surface. Remove objectionable material detrimental to proper compaction or to placing full depth of topsoil. If the top three inches of subgrade has become compacted before placement of topsoil, harrow or otherwise loosen rough graded surface to receive topsoil to a depth of three inches immediately prior to placing topsoil.

#### 4.55 FINISH GRADING

4.56 Uniformly grade rough graded areas within limits of the grading limit line to finish grade elevations indicated.

4.57 Grade and compact to smooth finished surface within tolerances specified, and to uniform levels or slopes between points where finish elevations are indicated or between such points and existing finished grade.

4.58 Grade areas adjacent to building lines so as to drain away from structures and to prevent ponding.

4.59 Finish surfaces free from irregular surface changes, and as follows:

- A. Grassed Areas: Finish areas to receive topsoil to within one inch above or below the required subgrade surface elevations.

- B. Walks: Place and compact subbase material as specified. Shape surface of areas under walks to required line, grade and cross section, with the finish surface not more than 1/2 inch above or below the required subbase elevation.
- C. Pavements: Place and compact subbase material as specified. Shape surface of areas under pavement to required line, grade and cross section, with the finish surface not more than 1/2 inch above or below the required subbase elevation.

4.60 MAINTENANCE AND RESTORATION

- 4.61 Restore grades to indicated levels where settlement or damage due to performance of the work has occurred. Correct conditions contributing to settlement. Remove and replace improperly placed or poorly compacted fill materials.

- 4.62 Restore pavements, walks, curbs, lawns, and other exterior surfaces damaged during performance of the work to match the appearance and performance of existing corresponding surfaces as closely as practicable.

- 4.63 Water seeded areas as required until physical completion of the work.

4.64 DISPOSAL OF EXCESS AND UNSUITABLE MATERIALS

- 4.65 Remove from property and dispose of excess and unsuitable materials, including materials resulting from clearing and grubbing and removal of existing improvements.

- 4.66 Transport excess and unsuitable materials, including materials resulting from clearing and grubbing and removal of existing improvements, to spoil areas on property, and dispose of such materials as directed.

- 4.67 Transport excess topsoil to areas on property designated by the Engineer. Smooth grade deposited topsoil.

4.68 FIELD QUALITY CONTROL

- 4.69 Special Inspections: A qualified special inspector shall perform the following special inspections:

- A. Determine prior to placement of fill that site has been prepared in compliance with requirements.
- B. Determine that fill material and maximum lift thickness comply with requirements.

- C. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.
- 4.70 Testing Agency: A qualified geotechnical engineering testing agency shall perform tests and inspections.
- 4.71 Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- 4.72 When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.
- 4.73 PROTECTION
- 4.74 Protect graded areas from traffic and erosion, and keep them free of trash and debris.
- 4.75 Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
  - A. Scarify or remove and replace soil material to depth as directed by Engineer; reshape and recompact.
- 4.76 Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
  - A. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

END OF SECTION

## SECTION 312319 - DEWATERING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes construction dewatering.

#### 1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 31 20 00: Excavation and Fill

#### 1.3 SUBMITTALS

- A. Field quality-control reports.
- B. Existing Conditions: Using photographs, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before work begins.
- C. Record Drawings: Identify locations and depths of abandoned-in-place dewatering equipment.
- D. Shop Drawings: Submit drawings and diagrams, with all pertinent data, showing the dewatering system proposed for use. Indicate the spacing and location of wellpoints and reading wells, and location of header lines, pumps, valves and discharge lines.

#### 1.4 QUALITY ASSURANCE

- A. Qualifications: The work of this Section shall be performed by a firm experienced in wellpoint dewatering work. The firm shall have satisfactorily completed such work for at least 5 projects of comparable size.
- B. The dewatering system shall consist of equipment, appliances and materials designed or suitable for controlling groundwater in construction work.

#### 1.5 PROJECT CONDITIONS

- A. Blasting and the use of explosive materials will not be permitted.

### PART 2 PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.
  - 1. Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer.
  - 2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
  - 3. Prevent surface water from entering excavations by grading, dikes, or other means.
  - 4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
  - 5. Remove dewatering system when no longer required for construction.
- B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
  - 1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site or surrounding area.
  - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Provide temporary grading to facilitate dewatering and control of surface water.



### 3.2 INSTALLATION

- A. Install the dewatering system in accordance with approved shop drawings and as required by site conditions. Locate elements of the system to allow a continuous dewatering operation without interfering with the installation of any permanent project work.
  - 1. Space well points or wells at intervals required to provide sufficient dewatering.
  - 2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- B. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails.

### 3.3 OPERATIONS

- A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
  - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
  - 2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
  - 3. Maintain piezometric water level a minimum of 24 inches below bottom of excavation.
- C. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.
- D. Remove dewatering system from project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap below overlying construction.

### 3.4 FIELD QUALITY CONTROL

- A. Maintain a careful check to detect any settlement in existing adjacent Work. Notify the Engineer of any signs of settlement. Establish settlement point benchmarks and take periodic readings when directed.
- B. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation. Prepare reports of observations.

3.5 PROTECTION

- A. Protect and maintain dewatering system during dewatering operations. Promptly repair damages to adjacent facilities caused by dewatering.

3.6 REMOVAL

- A. When the dewatering system is no longer required and when directed, dismantle and remove the system and all appurtenances from the site.

END OF SECTION

## SECTION 312513 - EROSION AND SEDIMENT CONTROLS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes:
  - 1. Furnish, install, inspect, maintain, and remove soil erosion and sediment control measures during construction as shown on the Contract Documents prepared for this project.
  - 2. Minimize the potential short-term adverse environmental impacts associated with construction activity in environmentally sensitive areas.
  - 3. Assure the quantity and quality of stormwater runoff is not substantially altered due to construction activities.
  - 4. Stabilize slopes and protect offsite areas by the installation and maintenance of stabilization and erosion control measures.
  - 5. Dewatering operation procedure.

#### 1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 31 20 00: Excavation and Fill

#### 1.3 REFERENCE STANDARDS

- A. New York Standards and Specifications for Erosion and Sediment Control, NYSDEC, latest edition.
- B. NYSDEC: Reducing the Impacts of Stormwater Runoff for New Development, latest edition.
- C. NYSDEC Environmental Conservation Law, Article 17. Titles 7, 8 and Article 70.
- D. 6 NYCRR Parts 611 – 613 and all additions.
- E. OSHA 40 CFR Part 258 and all additions. New York State: Standards and Specifications for Erosion and Sediment Control, latest edition.

#### 1.4 PROJECT CONDITIONS

- A. Install and maintain the temporary storm water and diversion control items as shown on the drawings before starting any grading or excavation. Provide any temporary sediment and erosion control measures that may be required within limits of the work, including any staging areas, throughout construction in conformance with the plan, and as directed by the Owner's Representative. Place the permanent control practices required before the removal of the temporary storm water diversion and control items.
- B. During construction conduct operations in such a manner as to prevent or reduce to a minimum any damage to any water body from pollution by debris, sediment, chemical or other foreign material, or from the manipulation of equipment and/or materials in or near a stream or ditch flowing directly to a stream. Any water which has been used for wash purposes or other similar operations which become polluted with sewage, silt, cement, concentrated chlorine, oil, fuels, lubricants, bitumens, or other impurities shall not be discharged into any water body.
- C. In the event of conflict between these specifications and the regulation of other Federal, State, or local jurisdictions, the more restrictive regulations shall apply.
- D. The Work shall consist of furnishing, installing, inspecting, maintaining, and removing soil and erosion control measures as shown on the contract documents or as ordered by the Owner's Representative during the life of the contract to provide erosion and sediment control.
- E. Temporary structural measures provide erosion control protection to a critical area for an interim period. A critical area is any disturbed, denuded slope subject to erosion. These are used during construction to prevent offsite sedimentation. Temporary structural measures shall include check dams, construction road stabilization, stabilized construction entrance, dust control, earth dike, level spreader, perimeter dike/swale, pipe slope drain, portable sediment tank, rock dam, sediment basin, sediment traps, silt fence, storm drain inlet protection, straw/hay bale dike, access waterway crossing, storm drain diversion, temporary swale, turbidity curtain, water bars or other erosion control devices or methods as required.
- F. Permanent structural measures also control protection to a critical area. They are used to convey runoff to a safe outlet. They remain in place and continue to function after completion of construction. Permanent structural measures shall include debris basins, diversion, grade stabilization structure, land grading, lined waterway (rock), paved channel, paved flume, retaining wall, riprap, rock outlets, and stream bank protection or other erosion control devices or methods as required.
- G. Vegetative measures shall include brush matting, dune stabilization, grassed waterway, vegetating waterway, mulching, protecting vegetation, seeding, sod, straw/hay bale dike, stream bank protection, temporary swale, topsoil, and vegetating waterways.

- H. Biotechnical measures shall include wattling (live fascines, brush matting, brush layering, live cribwall, and branchpacking) vegetated rock gabions, live staking, tree revetment, and fiber rolls.

## 1.5 DEFINITIONS

- A. Stabilized Construction Entrance: A stabilized pad of aggregate underlain with geo-textile where traffic enters a construction site to reduce or eliminate tracking of sediment to public roads.
- B. Dust Control: Prevent surface and air movement of dust from disturbed soil surfaces.
- C. Portable Sediment Tank: A compartmented tank to which sediment laden water is pumped to retain sediment before pumping the water to adjoining drainage ways.
- D. Sediment Basin: A barrier constructed across a drainage way to intercept and trap sediment.
- E. Sediment Traps: A control device formed by excavation to retain sediment at a storm inlet or other points of collection.
- F. Silt Fence: A barrier of geo-textile fabric installed on contours across the slope to intercept runoff by reducing velocity. Replace after 1 year.
- G. Storm Drain Inlet Protection: A semi-permeable barrier installed around storm inlets to prevent sediment from entering a storm drainage system.
- H. Straw/Hay Bale Dike: Intercept sediment laden runoff by reducing velocity. Replace after 3 months.
- I. Storm drain Diversion: The redirection of a storm drain line or outfall channel for discharge into a sediment trapping device.
- J. Temporary Swale: A temporary excavated drainage swale.
- K. Protecting Vegetation: Protecting trees, shrubs, ground cover and other vegetation from damage.
- L. Temporary Seeding: Erosion control protection to a critical area for an interim period. A critical area is any disturbed, denuded slope subject to erosion.
- M. Permanent Seeding: Grasses established and combined with shrubs to provide perennial vegetative cover on disturbed, denuded, slopes subject to erosion.
- N. Sod: Used where a quick vegetative cover is required.

## 1.6 SUBMITTALS

- A. Product Data: Manufacturer's catalog cuts, specifications and installation instructions.
- B. Contingency Action Plan for prompt remedial action in the event spillage of petroleum products or other pollutants should occur. Contingency Action Plan shall be submitted to the Engineer for acceptance prior to the start of construction.
- C. Name and location of all material suppliers.
- D. Certificate of compliance with the standards specified above for each source of each material.
- E. List of disposal sites for waste and unsuitable materials and all required permits for use of those sites.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Silt Fence
  - 1. Mirafi, Envirofence 365 South Holland Drive, Pendergrass, Ga, 30567, (888) 795-0808, <http://www.tencategeo.us/en-us/>
  - 2. Filter X
  - 3. Stabilinka T140N
  - 4. Approved equivalent
- B. Filter fabric inlet protection
- C. Stone and block inlet protection
- D. Temporary filters for inlet protection
- E. Hardwood staking material
- F. Stone material
- G. Dry Rip Rap
  - 1. NYSDOT Standard Specification Section 620

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Prior to any construction activities, install temporary erosion and sediment control barriers or measures as indicated on the Contract Drawings, per manufacturer's specifications.

- B. The Contractor shall be required to protect and preserve existing trees and shrubs in areas designated on the Contract Drawings. Contractor shall replace any tree or shrubs damaged in kind to the satisfaction of the Owner.
- C. The Contractor shall contact the Engineer once the erosion and sediment control structures have been installed.
- D. Prior to commencement of construction, the Engineer shall conduct an assessment of the site and certify that the appropriate erosion and sediment control structures as shown on the Contract Drawings have been adequately installed and implemented.
- E. Staging of Earthwork Activities: All earthwork shall be scheduled so that the smallest possible areas will be unprotected from erosion for the shortest time feasible.
- F. Vegetation adjacent to or outside of access roads or rights-of-way shall not be damaged.
- G. The Engineer has the authority to limit the surface area of erodible earth exposed by earthwork operations and to direct the Contractor to provide immediate temporary or permanent erosion measures to minimize damage to property and contamination of watercourses and water impoundments. Under no circumstances will the area of erodible earth material exposed at one time exceed 5 acres. The Engineer may increase or decrease this area of erodible earth material exposed at one time as determined by their analysis of project, weather and other conditions. The Engineer may limit the area of clearing and grubbing and earthwork operations in progress commensurate with the Contractor's demonstrated capability in protecting erodible earth surfaces with temporary, permanent, vegetative or biotechnical erosion control measures.
- H. Schedule the work so as to minimize the time that earth areas will be exposed to erosive conditions. Provide temporary structural measures immediately to prevent any soil erosion.
- I. Provide temporary seeding on disturbed earth or soil stockpiles exposed for more than 7 days or for any temporary shutdown of construction. In spring, summer or early fall apply rye grass at a rate of 1 lb/ 1000 sq.ft. In late fall or early spring, apply certified Aroostook Rye at a rate of 2.5 lbs./ 1000 sq. ft. Apply hay or straw at a rate of 2 bales/ 1000 sq. ft. or wood fiber hydromulch at the manufacturer's recommended rate. Hay or straw shall be anchored.
- J. Provide temporary grading to facilitate dewatering and control of surface water.
- K. Coordinate the use of permanent controls or finish materials shown with the temporary erosion measures.
- L. After final stabilization has been achieved, temporary sediment and erosion controls must be removed. Areas disturbed during removal must be stabilized immediately.

- M. Disposal of spoil material shall not be in any flood plain, wetland, stream, brook, or sensitive environmental area. The Contractor shall dispose of spoils within staging areas and provide sediment control barriers accordingly.

### 3.2 CLEARING

- A. Tree trunks and roots, vegetation, and project debris shall not be buried on site.
- B. Staging areas (for storage of materials and stockpiles) shall be located as shown on the plans. Where areas must be cleared for staging area temporary structures, provisions shall be made for regulating drainage and controlling erosion.
- C. All abandoned or useless objects including equipment, supplies, personal property, rubbish, (including those present prior to construction activities) should be removed from the project work area and properly disposed of in accordance with local, state, and federal regulations.

END OF SECTION



## SECTION 321216 - ASPHALT PAVING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Hot-mixed asphalt pavement for roads
- B. Hot-mixed asphalt patching

#### 1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 31 20 00: Excavation and Fill
- C. Section 32 17 23: Pavement Marking

#### 1.3 REFERENCE STANDARDS

- A. New York State Department of Transportation (DOT) Specification Section 400, latest edition.

#### 1.4 PROJECT CONDITIONS

- A. Environmental Requirements:
  - 1. Discontinue paving when surface temperatures fall below requirements listed in DOT Table 402-1 unless otherwise specified in the General Conditions of this Contract or as directed by the Engineer.
  - 2. Do not place asphalt concrete on wet surfaces, or when weather conditions otherwise prevent the proper handling or finishing of bituminous mixtures as determined by the Engineer.
  - 3. Pavement is restricted by dates listed in the General Conditions or by temperatures.

#### 1.5 SUBMITTALS

- A. Product Data:
  - 1. Paving Synthetics: including Manufacturer's name, specifications, MSDS as required and installation instructions (including adhesion type and rate) for each item specified.

2. Asphaltic Pavement: Include mix design from NYSDOT approved Batch Plant, Mix Design Test results that are less than 6 months old
- B. Batch plant name, NYSDOT Plant Number, and location of asphalt plant.
- C. Pavement Quality Control Submittals: Material Delivery Tickets
  1. At the time of delivery, a copy of the delivery ticket must be presented to the Director's Representative with the following minimum information:
    - a. Ticket Number.
    - b. Plant Identification.
    - c. Project Name.
    - d. Mix Type.
    - e. Quantity of material in vehicle.
    - f. Date and Time.
- D. Qualification Data: For manufacturer and testing agency.
- E. Field quality-control reports.

## 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the NYSDOT.
- B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.
- C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the NYSDOT for asphalt paving work.
- D. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

## PART 2 PRODUCTS

### 2.1 AGGREGATES

- A. All aggregate used in design mixes shall be as specified in DOT Specification Section 401-2.02 B.; Coarse Aggregate Type F2 Conditions.
- B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel.
- C. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel.

### 2.2 ASPHALT MATERIALS

- A. General: Use locally available materials and gradations that exhibit a satisfactory record of previous installations.
- B. Asphalt Pavement: Paving materials shall comply with the New York State Department of Transportation Standard Specification dated "Current Version." Section 400 – Hot Mix Asphalt.
- C. Trueing & Leveling Course: DOT Table 401-1 Composition of Hot Mix Asphalt Mixtures, Type 5 (Shim).
- D. Asphalt Cement: ASTM D 3381 for viscosity-graded material. ASTM D 946 for penetration-graded material.
- E. Asphalt Cement Tack Coat: Material shall conform to NYSDOT Section 407 – Tack Coat.
- F. Prime Coat: Cut-back asphalt type, ASTM D 2027; MC-30, MC-70 or MC-250.

## 2.3 AUXILIARY MATERIALS

- A. Sand: ASTM D 1073 or AASHTO M 29, Grade Nos. 2 or 3.
- B. Joint Sealant: ASTM D 3405 or AASHTO M 301, hot-applied, single-component, polymer-modified bituminous sealant.
- C. Paving Synthetics: A non-woven fabric designed for use in pavement rehabilitation to reduce reflective cracking, act as a vapor barrier and have one side heat bonded only.
  - 1. Tensar Triax Geogrid
  - 2. Tencate
  - 3. Propex Fabrics
  - 4. Fibertex
  - 5. Approved equivalent

## 2.4 MIXES

- A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:
  - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
  - 2. Base Course: NYSDOT (Type 37.5 F9 Base Course HMA, series 80 compaction) per Contract Drawings.
  - 3. Binder Course: NYSDOT (Type 19 F9 Binder Course HMA, series 80 compaction, Type 19FN) per Contract Drawings.

4. Top Course: NYSDOT (Type 9.5 F2 Top Course HMA, series 80 compaction, 9.5 F3) per Contract Drawings.
5. True and Leveling Course: Binder Course mix to be used in placed in a lift greater than 2 inches thick. Top Course mix to be used in a lift less than 2 inches thick.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify that sub-grade is dry and in suitable condition to support paving and imposed loads.
- B. Proof-roll subgrade in accordance with Specification Section 312000: Excavation and Fill
- C. Proceed with paving only after unsatisfactory conditions have been corrected.

#### 3.2 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving
- B. Sweep loose granular particles from surface of unbound-aggregate base course. Do not dislodge or disturb aggregate embedded in compacted surface of base course.
- C. Tack Coat: If top course is not placed within twenty-four (24) hours of binder placement, a tack coat shall be applied to clean surface prior to placement of top course. Apply uniformly to surfaces of pavement at a rate of 0.05 to 0.15 gal./sq. yd.
- D. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
- E. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

#### 3.3 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off using a self-propelled paving machine with vibrating screed. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
  1. Clean cracks and joints in existing hot-mix asphalt pavement.
  2. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
  3. Spread mix at minimum temperature of 250 deg F.
  4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes, unless otherwise indicated.

5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
  1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of mix along longitudinal joints.
  2. Complete a section of asphalt base course before placing asphalt surface course.
- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

### 3.4 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions with same texture and smoothness as other sections of hot-mix asphalt course.
  1. Clean contact surfaces and apply tack coat to joints.
  2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
  3. Offset transverse joints, in successive courses, a minimum of 12 inches.
  4. Construct transverse joints as described in AI MS-22, "Construction of Hot Mix Asphalt Pavements."
  5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
  6. Compact asphalt at joints to a density within 2 percent of specified course density.

### 3.5 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or vibratory-plate compactors in areas inaccessible to rollers.
  1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

### 3.6 INSTALLATION TOLERANCES

- A. Thickness: Compact each course to produce the thickness indicated within the following tolerances:
  1. Binder Course: Plus or minus 1/2 inch.
  2. Surface Course: Plus 1/4 inch, no minus.
- B. Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
  1. Base Course: 1/4 inch.
  2. Surface Course: 1/8 inch.
  3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

### 3.7 PATCHING

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Re-compact existing unbound-aggregate base course to form new sub-grade.
- B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd.
  1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.

2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- C. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

### 3.8 REPAIRS

- A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
  1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.
- B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.
  1. Clean cracks and joints in existing hot-mix asphalt pavement.
  2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with surface of existing pavement and remove excess.

### 3.9 FIELD QUALITY CONTROL

- A. Special Inspections: Contractor shall engage a qualified special inspector to perform the following special inspections:
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Thickness: In-place compacted thickness of hot-mix asphalt courses shall be determined according to ASTM D 3549.
- D. Surface Smoothness: Finished surface of each hot-mix asphalt course shall be tested for compliance with smoothness tolerances.
- E. In-Place Density: Testing agency shall take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.
  1. Reference maximum theoretical density shall be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
  2. In-place density of compacted pavement shall be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
    - a. One core sample shall be taken for every 1000 sq. yd or less of installed pavement, with no fewer than three cores taken.
    - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

- F. Replace and compact hot-mix asphalt where core tests were taken.
- G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

END OF SECTION



## SECTION 321823 - RUNNING TRACK SURFACING

### PART 1 – GENERAL

#### 1.1 SECTION INCLUDES

- A. Installation of IAAF approved polyurethane synthetic track system on track and field event areas as indicated on the Contract Documents including the layout and line striping of track lines and markings.

#### 1.2 RELATED SECTIONS

- A. Section 11 68 33 – Athletic Field Equipment
- B. Section 31 20 00 – Excavation and Fill
- C. Section 32 12 16 – Asphalt Paving

#### 1.3 SYSTEM DESCRIPTION

- A. Design Requirements
  - 1. Install new resilient track surfacing as indicated on the Contract Documents with the following:
    - a. IAAF approved, impervious, minimum 1/2"/13mm thick, all weather resilient track surface consisting of a urethane bound black SBR and EPDM base mat sealed with a polyurethane coating. The top surface shall include a structural spray creating a textured top.
  - 2. Track Dimensions and Markings: Provide metric track dimensions and markings conforming to the rules of the National Federation of State High School Associations (NFHS). Verify and certify dimensions and markings as follows:
    - a. Guarantee all calculations of all dimensions needed to properly mark the track "to be accurate and correct in accordance with the current governing rules and regulations." Ensure that all dimensions appear on an as-built drawing with date, name and address of the entity making the guarantee.
    - b. Provide certification by a professional engineer or licensed land surveyor from the State of New York with the proper stamp or certification, date and signature. The certification shall state that "all points shown on as-built drawings were accurately marked and properly designated on the track as shown."
    - c. Guarantee all markings on the track by date, name and address of applicator on the asbuilt drawing indicating that "all markings applied were made using designated marks and in accordance with the current governing rules and regulations and are as shown."

#### 1.4 SUBMITTALS

- A. Comply with the requirements of Section 01 33 00 – Submittal Procedures and as modified below.
- B. Product Data: Submit manufacturer's name, specifications and installation instructions for each item specified. Surfacing system components shall exactly adhere to the minimum tested and certified standards set forth by the International Association of Athletic Federations (IAAF).
- C. Samples: Submit three samples of materials.
- D. A contractor reference list of ten completed outdoor track facilities installed within the last two years of the exact same synthetic track surfacing system scheduled to be installed must be submitted for approval. The reference list must include contact names and phone numbers and must be under the current contractor's name including the installing supervisor.
- E. A current IAAF test report certifying that the product to be installed complies with the current IAAF Performance Standards for Synthetic Surface Athletic Tracks (Outdoors) with the documented certified test results.
- F. Quality Control Submittals
  - 1. Qualifications Certification: Submit written certification or similar documentation signed by the applicable subcontractor, prime contractor and/or manufacturer (where applicable), indicating compliance with the "Resilient Track Surface Installer Qualifications" requirements specified below in the "Quality Assurance" section of this specification.
  - 2. Experience Listing: Submit a list of completed projects using the products proposed for this project, including owner's contact information and telephone number for each project, demonstrating compliance with the "Quality Assurance" section of this specification.
- G. Closeout Procedures: Comply with the requirements of Section 01 77 00. Submittal to include written instructions for the maintenance of the resilient track surface, including the name of the service representative.

#### 1.5 QUALITY ASSURANCE

- A. General: The systems listed reflect the intent to establish required running track surface function and standard of quality for construction. The installed surfacing shall comply with the current material testing guidelines published by the American Society of Testing and Materials (ASTM).
- B. Resilient Track Surface Installer Qualifications:

1. The Contractor placing the track surface must be a manufacturer approved installer.
2. The track surfacing contractor must furnish evidence that they have been in business for a period of three years under the present corporate name, and, if required, furnish financial statements for each of the past three years.
3. The installer shall have completed a minimum of ten outdoor resilient track surfacing applications within the last two years utilizing the proposed IAAF certified surfacing materials under the current corporate business name.
4. The Contractor must have a minimum of ten years experience in the installation of poured-in-place, two component, elastomeric polyurethane synthetic track surfacing.
5. The Contractor is required to provide documentation that shows the selected specified product complies with current IAAF Performance Standards for Synthetic Surfaced Athletic Tracks (Outdoor) and is certified in terms of the IAAF certification system as updated to present day.
6. The installer must have one full time employee on staff with a "Certified TrackBuilder (CTB)" designation as acknowledged by the American Sports Builder's Association. A current CTB certificate must be provided as part of the submittal process for this project.

C. Resilient Track Surface Manufacturer Qualifications

1. The Manufacturer must have a minimum of ten years experience manufacturing polyurethane for synthetic track surfaces.
2. The Manufacturer must offer a minimum of five IAAF certified track systems.
3. The Manufacturer must be ISO 9001 certified.
4. The Manufacturer must supply an affidavit stating that the surfacing system components conform to the IAAF tested and certified property standards.

1.6 WARRANTY

- A. Synthetic Track Surface: Provide a warranty for a minimum five year period from the date of surface acceptance against defects in workmanship, labor and materials. The warranty coverage shall not be prorated nor limited by the usage of the track.
- B. Track Linestriping and Markings: Provide a warranty for a minimum two-year period from the date of acceptance against defects in workmanship, labor and materials.
- C. Synthetic surfacing material found to be defective as a result of faulty workmanship and/or material failure shall be replaced or repaired at no charge to the Owner upon written notification within the warranty period.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Establish and maintain required lines and elevations for grade control.

## 1.8 SEQUENCING AND SCHEDULING

- A. Proceed with and complete resilient track surface installation as rapidly as portions of the track and field area become available, working within seasonal limitations for the work required.

## PART 2 PRODUCTS

### 2.1 MANUFACTURER

- A. For convenience, the basis of design of details and specifications for running track surfacing within the Contract Documents have been based on products by Beynon Sports, Cockeysville, Maryland (Telephone #410-771-9473) or approved equal to establish quality and function.
- B. Track surfaces are described as follows:
  - 1. IAAF approved red choke coat track system similar to "BSS 300 Synthetic Track Surfacing System."

### 2.2 MATERIALS

- A. Elastomeric Polyurethane
  - 1. BEYPUR, the two-component U.V. stabilized elastomeric polyurethane compounded from polyol and isocyanate components, based on one hundred percent (100%) Methylene Diphenyl Isocyanate (MDI). No Toluene Diisocyanate Isocyanate (TDI) will be allowed.
  - 2. The elastomeric polyurethane shall be red in color.
- B. EPDM Granules
  - 1. The EPDM granulates shall be 1 to 3mm in size and peroxide cured.
  - 2. The EPDM granulates and the UV stabilized elastomeric polyurethane shall be color matched.
- C. Rubber Granulate of the base course
  - 1. Styrene Butadiene Rubber (SBR) processed ground to a graded size of 1-3mm.
  - 2. A maximum of 82%, by weight of the paved-in-place base layer, of SBR will be allowed.
- D. Single Component Polyurethane Binder
  - 1. A single-component polyurethane binder with a long cure time for use in paved mat specifications. A minimum of 18%, by weight of the paved-in-place base layer.
- E. Seal Coat

1. Two component polyurethane resin pigmented to match the color of the wearing coat. The material must be applied by a squeegee to insure the black mat is sealed. Dusting of the base mat will not be considered an acceptable installation method.
- F. Line Marking Paint
  1. All line and event markings shall be applied in one coat by experienced personnel utilizing the Manufacturer's recommended pigmented paint compatible with the specified waterborne track surfacing material.

## 2.3 IAAF AND ASTM PERFORMANCE STANDARDS

- A. Synthetic Track System
- B. Thickness: minimum 12 mm
  1. Force Reduction: 35 – 50%
  2. Vertical Deformation: 0.6 – 1.8 mm
  3. Friction: Greater than or equal to 0.5 (47 TRRL Scale)
  4. Tensile Strength: Greater than or equal to 0.5 MPa
  5. Elongation at Break: Greater than or equal to 40%
  6. Color: Red

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Installer Verification of Conditions: Examine conditions under which running track surfacing is to be constructed with the materials and components specified in this section. Affected Prime Contractors, the Owner's Representative and the Project Designer shall be notified in writing of any conditions detrimental to the proper and timely installation of the work. When the installer confirms conditions as being acceptable to ensure proper and timely installation of the work and to ensure requirements of applicable warranties or guarantees can be satisfied, submit written confirmation to the Project Designer. Failure to submit written confirmation and subsequent installation will be assumed to indicate conditions are acceptable to the installer.

### 3.2 PREPARATION

- A. The asphalt base course shall be tested for planarity using a ten foot straight edge. Leveling work, if necessary shall be performed so that the finished surface slope is 1%. Low spots shall be repaired prior to the installation of the resilient track surfacing.

- B. Following inspection of asphalt macadam and allowing for the required curing time of the base surface, the entire track area shall be thoroughly cleaned, removing any foreign and loose material.
- C. Installation of the synthetic track surfacing shall not take place if adjacent or concurrent construction generates excessive dust or abrasives of any other by product that, in the opinion of the installer, would be harmful to the track material.
- D. Work shall be delayed if weather and or climatic conditions are detrimental to the proper installation of the synthetic track surfacing. The track surfacing installation shall only be executed in dry conditions.

### 3.3 RESILIENT TRACK SURFACING APPLICATION

- A. Synthetic Track System
  - 1. Prior to the application of any track surfacing materials, the asphalt base shall be inspected for conformity to planarity requirements. The surface shall not deviate from the planned cross slope for the width of the track by more than maximum 0.2% slope and more than 0.1% slope in the running length of the track. Additionally, the finished asphalt shall not vary more than 1/8" under a 10 feet straight edge. All areas not in conformance with the above requirements shall be repaired with compatible materials as approved by the Manufacturer and allowed to cure prior to the application of the synthetic track surface.
  - 2. The asphalt base course should be cured for a minimum of 14 days prior to the application of the synthetic track surface.
  - 3. The underlying asphalt track surface should be flooded with water. Patch asphalt if bird baths exist after 20 minutes of drying time. Problem bird bath areas shall be milled to a 1" depth with tapered 45-degree edge notch condition and repaved with the specified asphalt top course material. Cold tar patching, skin patching or sand mix patching will not be considered acceptable patching practices for use under the new synthetic track surfacing scheduled to be installed above.
  - 4. cleaned and removed, either by milling out or removing and replacing with new keyed in asphalt. The minimum depth of any asphalt replacement shall be one inch with the curing time for the asphalt base being 28 days.
  - 5. The track surfacing contractor must accept the planarity and surface condition of the asphalt base macadam layer in writing prior to installing the rubber track surfacing above.
  - 6. The track surface shall be cleaned of any loose or foreign particles with a power blower, pressure washer or similar equipment prior to the commencement of work.

7. The material components of the specified waterborne synthetic track surfacing system shall be processed and installed by specially designed machinery and equipment. A mechanically operated paver with variable regulated speed and thermostatically controlled screed shall be used in the installation of the base mat. The track wearing course shall be installed using automatic electronic portioning providing for continuous mixing and feeding for an accurate, quality-controlled installation.
8. Apply polyurethane primer uniformly over the entire surface at a rate of no less than 0.3 pounds per square yard. Allow a minimum of 30 minutes curing time before the application of base mat material. Only those areas to be surfaced that day should be primed.
9. The base mat shall consist of a 20 to 22% range of single component polyurethane base mat binding agent and 78 to 80% range, 1 to 4 mm EPDM rubber base mat granulate by weight containing no dust and shall be applied at a temperature of no less than 40 degrees F.
10. The track surfacing mixture shall be prepared in a mechanical mixer or suitable continuous mixer which is clean and dry. The black rubber granules and polyurethane binding agent shall be blended together for a minimum period of two minutes.
11. The thoroughly mixed base mat material shall be applied using a mechanically operated screed machine which has an electrically heated screed to ensure both smoothness and compaction of the surface.
12. All joint work shall be flush with the adjacent mat. Joints which have cured shall have their edges primed with polyurethane primer. The laying procedure shall be bay to bay, limiting the length of the passes so as not to have any cold/cured joints between the bays. Any small irregularities remaining in the surface after the tandem leveler has passed may be removed using a light polyethylene or Teflon roller.
13. After the base mat has cured properly, the entire track surface area shall receive squeegee applied, two component seal/choke coat, applied at a rate of no less than 3.0 pounds per square yard completely sealing the base mat.
14. After the seal coat layer has cured properly, the entire track surface area shall receive two structural spray layers consisting of 60% red pigmented polyurethane structural spray binder and 40% red pigmented 0.5–2.0 mm EPDM rubber spray layer granulate. Each spray layer shall be uniformly applied at a rate of no less than 1.5 pounds per square yard for total spray coverage of not less than 3.0 pounds per square yard for the two-spray layer.
15. The thickness of the specified aliphatic waterborne synthetic track surface shall be minimum 13mm. The Owner will require four, 3" diameter samples be cored from representative track surface areas by their Independent Testing Agency prior to final acceptance of the track surface. Core sample thickness, consistency and density will be evaluated for acceptability. The track surfacing contractor will be responsible to patch core areas at no cost to the Owner.

16. All line and event markings shall be applied by experienced personnel utilizing polyurethane-based paint compatible with the track surfacing recommended by the track surfacing manufacturer.

### 3.4 TRACK MARKING APPLICATION

- A. Apply paint to running track only after the surface has properly cured. All lane linestriping and marking paint shall be applied in strict accordance with the Manufacturer's written instructions.
- B. All markings shall be applied in accordance with the rules and regulations of the National

### 3.5 TRACK MARKINGS, MEASUREMENTS AND CALCULATIONS

- A. All track markings, measurements and calculations shall comply with the following:
  1. New track markings shall match existing track markings exactly. Have a State Licensed Land Surveyor provide an as-built of the existing track surface for use in preparing the new shop drawings.
  2. Locate and establish radius points.
  3. Establish and set all necessary control points.
  4. Layout all lines and markings to within a  $\pm 1/2$ " tolerance.
  5. Prepare all necessary drawings certified by a State Licensed Land Surveyor or Professional Engineer. Obtain list of standard events requiring marking from the Owner prior to proceeding with track markings. All markings shall be applied in accordance with the rules and regulations of the National Federation of High School Associations (NFHS). Submit drawing to the Project Designer for approval.
  6. Provide all computations and measurements. Use competent, experienced and fully qualified personnel to make measurements. Measurements to be performed by a New York State Licensed Land Surveyor or Professional Engineer.
  7. Establish all curve locations using a transit or theodolite capable of reading direct to 20 degrees.
  8. Apply one heavy coat of paint to all lines and markings.
  9. Use paints directly from original containers. NO THINNING OF PAINTS SHALL BE ALLOWED. Use the amount of paint as recommended by the manufacturer.

### 3.6 ADJUSTING AND CLEANING

- A. Repairs and Protection of Running Track Surfacing
  1. Repair or replace defective running track surfacing as directed by the Project Designer.
  2. Protect resilient surfacing from damage until acceptance of the running track construction.



END OF SECTION

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## SECTION 321824 - TENNIS COURT SURFACING

### PART 1 – GENERAL

#### 1.1 SECTION INCLUDES

- A. This work includes Inspection of asphalt paving or concrete paving, cleaning and prepping surface to receive tennis court surfacing, placing tennis court surfacing material, line and graphics painting, clean up and warranty.

#### 1.2 RELATED SECTIONS

- A. Section 11 68 33 – Athletic Field Equipment
- B. Section 31 20 00 – Excavation and Fill
- C. Section 32 12 16 – Asphalt Paving

#### 1.3 QUALITY ASSURANCE

- A. Installing firm: Installer must regularly engage in construction and color acrylic surfacing. Documented experience in athletic surface paving, and acrylic color system applications must be provided. Minimum of 10 projects similar in complexity in the last 3 years.
- B. Surfacing shall conform to the guidelines of the ASBA, (American Sports Builders Association), and USAPA (U.S. A. Pickleball Association) respectively.

#### 1.4 SUBMITTALS

- A. Provide manufacturer specifications for all products, asphalt mix design, color chart and installation instructions.
- B. Shop drawings indicating layout and placement of asphalt, color system, lines, net systems, fence and gates.

#### 1.5 MATERIAL HANDLING AND STORAGE

- A. Store materials in accordance with manufactures specifications and MSDS.
- B. All surfacing material shall be non-flammable.
- C. NO MATERIAL STORED ON SITE during the duration of the project unless fully secured with fencing.

1.6 GUARANTEE

- A. Provide guarantee against defects in the materials and workmanship for a period of one (1) year from the date of substantial completion unless otherwise stated.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Establish and maintain required lines and elevations for grade control.
- B. Do not apply asphalt tennis court surface color coating system when air or surface temperatures are below 50 degrees F during application or within 24 hours after application.
- C. Do not apply asphalt tennis court surface color coating system when rain is expected during application or within 24 hours after application.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. U.S. Tennis Court Construction Company Lockport, IL 60441/ Elite Sport Coating System.
- B. Local Asphalt plant with qualified mix.
- C. Approved equal.

2.2 MATERIALS

- A. Aggregate Base Course (CA-6)- graded and compacted base course.
- B. HMA Binder Course (N-50 Binder Course)- Lower course of pavement with maximum aggregate size no more than three-quarters of one inch (3/4").
- C. HMA Surface Course (N-30 Surface Course) -fine graded asphalt course with one half inch (1/2") maximum aggregate or smaller, free of reclaimed asphalt shingles (RAS) and with no more than 25% reclaimed asphalt pavement (RAP), applied over reinforcement grid.
- D. Tennis Court Surfacing shall be Action Pave, manufactured by Crafcro Inc. 3600, US Route 20, Nassau, NY 12123. Approved equivalents are acceptable.

- E. Depressions or irregularities shall be filled with "Action Pave Acrylic Crack and Leveling Binder Patch", manufactured by Crafcro Inc., Nassau, NY. Approved equivalents are acceptable. Material shall be a super durable acrylic emulsion specifically designed for mixing with mineral aggregate (silica sand) and portland cement to patch cracks, level low spots and smooth paving joints and other surface irregularities.
- F. Resurfacer material for the surface course shall be "Action Pave Acrylic Resurfacer", manufactured by Crafcro Inc., Nassau, NY. Approved equivalents are acceptable. Material shall be a heavily fortified, sand filled, 100% acrylic primer/base coat designed to bond to new asphalt and/or to improve pitted, oxidized, older surfaces before the color coats are installed.
- G. Acrylic Filler for the surface course shall be "Action Pave Acrylic Filler", manufactured by Crafcro Inc., Nassau, NY. Approved equivalents are acceptable. Material consisting of 100% acrylic emulsions, mineral fillers, special reinforcing pigments and pure silica sand that is applied over the Resurfacer to provide a uniform and controlled pigmented texture.
  - 1. The color coating system shall have playing characteristics similar to ITF Tennis Court Pace Classification: 3 Medium
  - 2. The manufacturer shall guarantee the material for two years from date of finished application against chalking, checking, fading, discoloration, or other adverse effects from ultraviolet rays of the sun, from weather moisture, or from weather temperatures.
  - 3. Material shall be delivered to the construction site in its original unopened containers clearly labeled with trade name and name of manufacturer.
- H. Acrylic Finish for the surface shall be equal to "Action Pave Acrylic Finish", manufactured by Crafcro Inc, Nassau, NY. Approved equivalents are acceptable. Material shall be a 100% acrylic emulsion that provides added durability and protects the surface against the sun's damaging ultraviolet rays.
- I. Colors for playing surface and apron areas shall be selected by the Architect from among the manufacturer's standard range of colors. Custom colors to be submitted by Pantone color number.
- J. The Color Finish Coats shall provide uniformity of texture and depth of color to provide a non-slippery and non-shining playing surface of uniform color for not less than two years of intensive use as a tennis surface. The Contractor and the manufacturer shall provide jointly such written assurances as are satisfactory to the Architect that their materials and application will provide this performance.
- K. Line Paint shall be equal to "Action Pave Acrylic Textured White Line Paint", manufactured by Crafcro Inc., Nassau, NY. Line paint shall be 100% acrylic emulsion type containing no alkyds, butadiene styrene or vinyl and shall be thinned with water only.

## PART 3 EXECUTION

### 3.1 WEATHER LIMITATIONS

- A. Do not install when raining or rain is imminent.
- B. Do not install if surface is wet or damp.
- C. Do not apply unless surface and air temperatures are 50°F and rising.
- D. Do not apply if surface temperature is more than 140°F.
- E. New Asphalt Pavement – Hot mix asphalt pavement (HMA) must comply with ASBA asphalt guidelines including mix design and compaction to comply with any warranty. New asphalt pavement must be aged at least 14 days before application and may require longer curing period
- F. The surface must be clean and free of grease, oil, or other debris.

### 3.2 SITE INSPECTION AND PREPARATION

- A. Examine soil to establish its suitability as a foundation for court construction.
- B. Remove and dispose of all trees and vegetation including root systems.
- C. Locate utilities.
- D. Proper grade elevation shall be set on proposed court areas.
- E. All excavating, filling, compacting, grading, and leveling required shall be performed so that the finish court surface has a slope of no less than 0.83% and 1% on a true plane from side to side or end to end. Net line crowning will not be acceptable.

### 3.3 BASE COURSE

- A. Aggregate base course shall be added as needed with a minimum thickness of eight inches (8") to obtain required elevations and compaction.
- B. Elevations to be set in base course with a 0.83%-1% pitch end to end or side to side.
- C. Proof roll with a fully loaded six-yard dump truck prior to asphalt paving.
- D. All soft areas shall be replaced with compacted aggregate base course

### 3.4 BINDER COURSE

- A. Machine apply and compact HMA Surface course to a compacted thickness of no less than two inches (2") over prepared stone base.
- B. HMA shall be free of marks, segregation and be placed to required uniform elevation with a smooth texture not showing tearing, shoving, or gouging.
- C. Paving equipment shall be equipped with auger extensions, and be self-propelled.
- D. Hand work shall be minimized to ensure the best possible finished surface.
- E. Rolling shall start as soon as the HMA can be compacted without displacement. Rolling shall continue until the HMA is thoroughly compacted and all roller marks have disappeared. Compact the HMA to a minimum in-place density of 94.0% of the Theoretical Maximum Specific Gravity.
- F. Binder course longitudinal joints shall be smooth and true; no deviation from level and true.
- G. Smoothness shall meet the requirements of no greater than one eighth inch (1/4") in ten feet (10').
- H. Binder course asphalt must be placed in one day, special care shall be taken to avoid cold seams.

### 3.5 SURFACE COURSE

- A. Machine apply and compact HMA Surface course to a compacted thickness of no less than one and one half inches (1.5") over HMA binder course.
- B. HMA shall be free of marks, segregation and be placed to required uniform elevation with a smooth texture not showing tearing, shoving, or gouging.
- C. Paving equipment shall be equipped with auger extensions, and be self-propelled.
- D. Hand work shall be minimized to ensure the best possible finished surface.
- E. Rolling shall start as soon as the HMA can be compacted without displacement. Rolling shall continue until the HMA is thoroughly compacted and all roller marks have disappeared. Compact the HMA to a minimum in-place density of 94.0% of the Theoretical Maximum Specific Gravity.
- F. Surface course longitudinal joints shall be smooth and true; no deviation from level and true.
- G. Smoothness shall meet the requirements of no greater than one eighth inch (1/8") in ten feet (10').

- H. Surface course asphalt must be placed in one day, special care shall be taken to avoid cold seams.

### 3.6 COURT DEPRESSIONS "BIRDBATHS"

- A. Testing: Surface shall be flooded with water by rain or manually with clean water. Surface shall be allowed to drain for 45-60 minutes in sunlight at 70°F. Remaining depressions holding enough water to cover a five cent piece (American Nickel) shall be marked.
- B. Birdbath shall be patched and leveled in accordance with recommendations of the manufacturer of the color finish system specified.
- C. Tack coat shall be applied to patched areas only prior to applying Acrylic Resurfacer.
- D. Start of tennis court surfacing application shall constitute acceptance of the base surface to receive tennis court surfacing.
- E. The bituminous asphalt pavement shall be thoroughly cured before application of the color surface system per the manufacturer's specifications. A minimum 14-day cure period is required.
- F. The area to be surfaced shall be clean and free of any loose particles or foreign substances (dirt, oil, etc.) prior to the commencement of work. The surface shall be cleaned by use of a power blower and high-pressure washer as needed.
- G. Prior to applying tennis court surfacing system, the net support post sleeves, fence posts, and center strap anchors shall be re-installed as required.

### 3.7 ACRYLIC FILLER COAT(S) (RESURFACER)

- A. Color Surface Application
  - 1. Patch all depressions and/or irregularities in the finished pavement surface, should this work be necessary, with Action Pave Acrylic Crack and Leveling Binder Patch.
  - 2. Apply 2 coats Action Pave Acrylic Resurfacer and 2 coats Action Pave Acrylic Colored Filler to cured asphalt surface.
  - 3. The application shall be made lengthwise on the surface with a wide squeegee and shall produce a uniform color throughout when viewed from a distance of 25 ft. from any edge of the court at midday.

### 3.8 ACRYLIC COLOR PLAYING SURFACE

- A. Complete a thorough inspection, remove any bumps or ridges in resurfacer coats, and clean surface of all loose dirt, leaves, or other debris.



- B. If the surface is to receive multiple colors, apply chalk lines to distinguish the court area from the perimeter area. Follow USTA & USAPA guidelines for court dimensions.
- C. Colors and their placement shall be determined by the owner. Colors and the placement of the colors shall be verified by the owner prior color applications.
- D. Textured acrylic color surface shall be applied in two (2) applications with a 50 durometer rubber squeegee. No application should be made until the previous application is thoroughly dry.
- E. Strictly follow manufactures guidelines and weather limitations.

### 3.9 LINE PAINTING

- A. Lines shall be carefully laid out in accordance with the ASBA or USAPA guidelines.
- B. Masking tape shall be applied and rolled to result in a two inch (2") wide width unless otherwise stated.
- C. Masked lines shall be primed with acrylic line primer to seal the void between the textured surface and masking tape edge.
- D. One (1) coat of textured white line paint shall be applied by brush or roller. NO SPRAY APPLICATIONS PERMITTED.

### 3.10 PROTECTION

- A. Erect temporary barriers to protect coatings during drying and curing.
- B. Lock gates to prevent use until acceptance by the owner.

### 3.11 CLEAN UP

- A. Site shall be cleared of all construction debris, all waste shall be disposed of offsite in accordance with local, state and federal regulations.
- B. Remove all barriers and locks.

END OF SECTION

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## SECTION 323113 - CHAIN LINK FENCES AND GATES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes:
  - 1. Fence framework, fabric and accessories.
  - 2. Excavation for post bases and center drop for gates.

#### 1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 03 30 00: Cast in Plan Concrete
- C. Section 31 20 00: Excavation and Fill

#### 1.3 REFERENCE STANDARDS

- A. ASTM A 53 for requirements of Schedule 40 piping.

#### 1.4 SUBMITTALS

- A. Shop Drawings: Complete detailed drawings for each height and style of fence and gate required. Include separate schedule for each listing all materials required and technical data such as size, weight, and finish, to ensure conformance to specifications.
- B. Product Data: Manufacturer's catalog cuts, specifications, and installation instructions for each item specified.
- C. Samples:
  - 1. Fence Fabric: Minimum one square foot.
  - 2. Fence and Gate Posts: Two each, one foot long, if requested.
  - 3. Miscellaneous Materials and Accessories: One each, if requested.
- D. Quality Control Submittals:
- E. Certificates: Affidavit required under Quality Assurance Article.

#### 1.5 QUALITY ASSURANCE

- A. Comply with standards of the Chain Link Fence Manufacturer's Institute.

- B. Fence shall be installed in accordance with ASTM F-567 and gates shall be installed in accordance with ASTM F-900.
- C. Provide steel fence and related gates as a complete compatible system including necessary erection accessories, fittings, and fastenings.
- D. Posts and rails shall be continuous without splices.

## 1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which installer agrees to repair or replace components of chain-link fences that fail in materials or workmanship within specified warranty period.
- B. Failures include, but are not limited to, the following:
  - 1. Faulty operation of gate operators and controls.
  - 2. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 3. Warranty Period: Five years from date of Substantial Completion.

## PART 2 PRODUCTS

### 2.1 STEEL FRAMEWORK

- A. All pipe shall be Schedule 40, conforming with ASTM F-1083.
- B. End Posts, Corner Posts and Pull Posts:
- C. 4' Fence Height Pipe: 2 inches O.D.
  - 1. 6' and 8' Fence Height Pipe: 3 inches O.D.
  - 2. 10' Fence Height Pipe: 6 inches O.D.
- D. Line Posts:
- E. 4' Fence Height Pipe: 2 inches O.D.
- F. 6' and 8' Fence Height Pipe: 2 1/2 inches O.D.
- G. 10' Fence Height Pipe: 3 inches O.D.
- H. Rails and Post Braces:
- I. 4' Fence Height Pipe: 1 5/8 inches O.D.
- J. 6' and 8' Fence Height Pipe: 1 5/8 inches O.D.
- K. 10' Fence Height Pipe: 1 5/8 inches O.D.

L. Metallic Coating for Steel Framework:

1. Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film.
2. External, Type B: Zinc with organic overcoat, consisting of a minimum of 0.9 oz./sq. ft. of zinc after welding, a chromate conversion coating, and a clear, verifiable polymer film. Internal, Type D, consisting of 81 percent, not less than 0.3-mil thick, zinc-pigmented coating.
3. Coatings: Any coating above.

2.2 STEEL FABRIC

- A. One-piece widths for fence heights up to 12'-0".
- B. Chain link, 2 inch mesh, No. 9 gauge
- C. Selvages: Top edge; bottom edge knuckled.
- D. Zinc-Coated (galvanized) Fabric: ASTM A 392, Type II, Class 1, 1.2 oz./sq. ft. with zinc coating applied after weaving.
- E. Aluminum wire ties shall not be allowed.

2.3 Bands:

- A. 6' Fence Height: 6 each bands per fence direction.
- B. 8' Fence Height: 8 each bands per fence direction.
- C. 10' Fence Height: 10 each bands per fence direction.

2.4 SWING GATE POSTS

- A. Single width of gate up to 6'-0" wide and less than 10'-0" high:
- B. Pipe: 2.875 inches OD (Schedule 40).
- C. Single width of gate 6'-0" to 12'-0" wide or over 10'-0" high:
- D. Pipe: 4 inches OD (Schedule 40).

2.5 SWING GATE FRAMES

- A. Up to 6'-0" high, and leaf width 8'-0" or less.
- B. Pipe: 1.660 inches OD (Schedule 40).

- C. Height: 6'-0" - 12'-0", or leaf width exceeding 8'-0":
- D. Pipe: 1.90 inches OD (Schedule 40).
- E. Assemble gate frames by welding or with special steel fittings and rivets for rigid connections. Install mid-height horizontal rails on gates over 10 feet high. When width of gate leaf exceeds 10 feet, install mid-distance vertical bracing of the same size and weight as frame members. When either horizontal or vertical bracing is not required, provide truss rods as cross bracing to prevent sag or twist.

## 2.6 SWING GATE HARDWARE

- A. Hinges: Non-lift-off type, offset to permit 180 degree swing, and of suitable size and weight to support gate. Provide 1-1/2 pair of hinges for each leaf over 6 feet high.
- B. Latch: Forked type for single gates 10 feet wide or less. Drop bar type with keeper for double gates and single gates over 10 feet wide complete with flush plate set in concrete. Drop bar length shall be 2/3 the height of the gate. Padlock eye shall be an integral part of latch construction.

## 2.7 MISCELLANEOUS MATERIALS AND ACCESSORIES

- A. Rails and Post Braces:
- B. Pipe: 1.660 inches OD, 2.27 pounds per linear foot (Schedule 40).
- C. Fittings and Post Tops: Steel, wrought iron, or malleable iron.
- D. Fasteners: Tamper-resistant cadmium plated steel screws.
- E. Stretcher Bars: One piece equal to full height of fabric, minimum cross-section 3/16 inch by 3/4 inch.
- F. Metal Bands (for securing stretcher bars): Steel, wrought iron, or malleable iron.
- G. Wire Ties: Conform to American Steel Wire gauges.
  - 1. For tying fabric to line posts, rails and braces: 9 gauge (.1483 inch) steel wire.
- H. Truss Rods: 3/8 inch diameter.
- I. Concrete: Portland Cement concrete having a minimum compressive strength of 4000 psi at 28 days.
- J. Terminal/ End/ Corner Post Foundations:
  - 1. 4' and 6' Fence Height Foundations: 3'-6" deep post embedment in 4' deep concrete footing, 12" inches diameter.
  - 2. 8' Fence Height Foundations: 4'-6" deep post embedment in 5' deep concrete footing, 18" inches diameter.

3. 10' and greater Fence Height Foundations: 5'-0" deep post embedment in 5' deep concrete footing, 18" inches diameter.
- K. Line Post Foundations:
  1. 4' and 6' Fence Height Foundations: 3'-6" deep post embedment in 4'-0" deep concrete footing, 12" inches diameter.
  2. 8' Fence Height Foundations: 4'-6" deep post embedment in 5' deep concrete footing, 12" inches diameter.
  3. 10' and greater Fence Height Foundations: 5'-0" deep post embedment in 5' deep concrete footing, 12" inches diameter.
- L. Spiral Paper Tubes:
  1. Sonotube by Sonoco Products Co., North Second St., Hartsville, SC 29550, (800) 377-2692.
  2. Slek/tubes by Jefferson Smurfit Corp., P.O. Box 66820, St. Louis, MO 63166, (314) 746-1100.
  3. Approved equivalent
- M. Cold Galvanizing Compound: Single component compound giving 93 percent pure zinc in the dried film, and meeting the requirements of DOD-P-21035A (NAVY).

## 2.8 FINISHES

- A. Steel Framework:
  1. Pipe: Galvanized in accordance with ASTM A 53, 1.8 ounces zinc per square foot.
- B. Fabric
  1. Galvanized Finish: ASTM A 392 class II zinc coated after weaving, with 2.0 ounces per square foot.
- C. Fence and Gate Hardware, Miscellaneous Materials, Accessories:
  1. Wire Ties: Galvanized Finish, ASTM A 90 1.6 ounces zinc per square foot, or aluminized finish, ASTM A 809 0.40 ounces per square foot.
  2. Hardware & Miscellaneous Items: Galvanized Finish, ASTM A 153 (Table 1)

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Clear and grub along fence line as required to eliminate growth interfering with alignment. Remove debris from State property.
- B. Do not begin installation of fence in areas to be cut until finished grading has been completed.

### 3.2 APPLYING PAVEMENT MARKING

- A. Install chain-link fencing according to ASTM F 567 and more stringent requirements specified.
- B. Space posts equidistant in the fence line with a maximum of 10 feet on center. For fences 16 feet and higher space posts a maximum of 8 feet on center.
- C. Setting Posts in Earth: Drill holes for post footings. If existing grade at the time of installation is below finished grade, provide spiral paper tubes to contain concrete to finish grade elevation. Set posts in center of hole and fill hole with concrete. Plumb and align posts. Vibrate or tamp concrete for consolidation. Finish concrete in a dome shape above finish grade elevation to shed water. Do not attach fabric to posts until concrete has cured a minimum of 7 days.
- D. Setting Posts in Rock: Drill holes into solid rock one inch wider than post diameter, 18 inches deep for end, pull, corner, and gate posts, and 12 inches deep for line posts. Set posts into holes and fill annular space with shrink-resistant grout.
- E. Locate corner posts at corners and at changes in direction. Use pull posts at all abrupt changes in grade and at intervals no greater than 500 feet. On runs over 500 feet, space pull posts evenly between corner or end posts. On long curves, space pull posts so that the strain of the fence will not bend the line posts.
- F. Install top rail continuously through post tops or extension arms, bending to radius for curved runs. Install expansion couplings as recommended by fencing manufacturers.
- G. Install bottom and intermediate rails in one piece between posts and flush with post on fabric side using special offset fittings where necessary.
- H. Brace corner posts, pull posts, end posts, and gate posts to adjacent line posts with horizontal rails.
- I. Diagonally brace corner posts, pull posts, end posts, and gate posts to adjacent line posts with truss rods and turnbuckles.
- J. Attach fabric to security side of fence. Maintain a 2 inch clearance above finished grade except when indicated otherwise. Thread stretcher bars through fabric using one bar for each gate and end post and 2 for each corner and pull post. Pull fabric tight so that the maximum deflection of fabric is 2 inches when a 30 pound pull is exerted perpendicular to the center of a panel. Maintain tension by securing stretcher bars to posts with metal bands spaced 15 inches oc. Fasten fabric to steel framework with wire ties spaced 12 inches oc for line posts and 24 inches oc for rails and braces. Bend back wire ends to prevent injury. Tighten stretcher bar bands, wire ties, and other fasteners securely.



- K. Position bolts for securing metal bands and hardware so nuts are located opposite the fabric side of fence. Tighten nuts and cut off excess threads so no more than 1/8 inch is exposed. Peen ends to prevent loosening or removal of nuts.
  - 1. Secure post tops and extension arms with tamper-resistant screws.
- L. Install gates plumb and level and adjust for full opening without interference. Install ground-set items in concrete for anchorage, as recommended by fence manufacturer. Adjust hardware for smooth operation and lubricate where necessary.
- M. Tension Wire: Support bottom edge of fabric with tension wire. Weave tension wire through fabric or fasten with hog rings spaced 24 inches oc. Tie tension wire to posts with 9 gauge wire ties.
- N. Wire brush and repair welded and abraded areas of galvanized surfaces with one coat of cold galvanizing compound.
- O. Restore disturbed ground areas to original condition. Topsoil and seed to match adjacent areas.

### 3.3 GATE INSTALLATION

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation.

### 3.4 ADJUSTING

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

END OF SECTION

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## SECTION 329200 - TOPSOIL AND SEEDING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. This Section includes:
  - 1. Topsoil.
  - 2. Soil Amendments.
  - 3. Fertilizing.
  - 4. Mulches.
  - 5. Lawn.
  - 6. Lawn Restoration.
  - 7. Erosion Control Materials.
  - 8. Maintenance.

#### 1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Section 312000: Excavation and Fill.

#### 1.3 SUBMITTALS

- A. Product Certification: Certification signed by manufacturers certifying that their products comply with specified requirements.
  - 1. Manufacturer's certified analysis for standard products.
  - 2. Analysis for other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- B. Certification of grass seed from seed vendor stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- C. Material test reports from qualified independent testing agency indicating and interpreting test results relative to compliance of the following materials with requirements indicated. Include percentages of organic matter, inorganic matter (silt, clay, and sand), deleterious material, pH, and mineral and plant-nutrient content.
  - 1. Analysis of existing surface soil.
  - 2. Analysis of imported topsoil.

- D. Report suitability of existing surface soil and imported topsoil for lawn and plant growth. State recommended quantities of soil amendments to be added to produce satisfactory results.

#### 1.4 DEFINITIONS

- A. Weeds: Vegetative species other than specified species to be established in given area.
- B. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Before expiration of required maintenance periods, Contractor is to submit maintenance instructions recommending procedures to be performed by Owner for maintenance of landscape during an entire year.

#### 1.6 QUALITY ASSURANCE

- A. Provide seed mixture in containers showing percentage of seed mix, germination percentage, inert matter percentage, weed percentage, year of production, net weight, date of packaging, and location of packaging.

#### 1.7 QUALIFICATIONS

- A. Seed Supplier: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience and a record of successful landscape establishment.
  - 1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site during times that work of this section is in progress.
- C. Testing Agency: To qualify for acceptance, an independent testing agency must demonstrate to Owner's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the work.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver packaged materials in sealed containers showing weight, analysis, and name of manufacturer.
- B. Protect materials from deterioration during delivery and while stored at site.

## 1.9 PROJECT CONDITIONS

- A. Utilities: Determine location of above grade and underground utilities prior to the start of Work. Perform Work in a manner which will avoid damage. Hand excavate, as required. Maintain grade stakes until removal is mutually agreed upon by the Engineer.
- B. Excavation: When conditions detrimental to lawn growth are encountered, such as rubble fill, adverse drainage conditions, or obstructions, notify the Engineer before planting.

## 1.10 COORDINATION AND SCHEDULING

- A. Coordinate with other site operations to avoid conflict and damage to new work.
- B. Planting season for Seeded areas: As indicated on the Contract Drawings.

## 1.11 WARRANTY

- A. General: The guarantee specified in this Section shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- B. Guarantee: Upon completion and acceptance of the landscaping, guarantee the materials for two years. Guarantee shall include material and labor costs. At the end of the guarantee period, the Owner's onsite representative shall inspect all planter materials. The Contractor shall promptly make all required replacements with plant materials meeting specifications.

## 1.12 LAWN MAINTENANCE

- A. Begin maintenance immediately after each area is planted and continue until acceptable lawns and plants are established, but for not less than the following periods:
  - 1. Lawns and Seeded Areas: 120 days after date of Substantial Completion.
  - 2. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established at that time, continue maintenance during the next planting season.
- B. Maintain and establish seeded areas by watering, weeding, replanting, and other operations. Roll, re-grade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth surface.

- C. Watering: Provide and maintain temporary piping, hoses, and watering equipment to convey water from sources and to keep grass uniformly moist to a depth of 4 inches. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
  - 1. Water all seeded areas at the minimum rate of 1 inch per week.
- D. Mow lawns as soon as there is enough top growth to cut with mower set at specified height for principal species planted. Repeat mowing as required to maintain specified height without cutting more than 40 percent of the grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain a grass height of 1½ to 2½ inches.

## PART 2 PRODUCTS

### 2.1 PLANTING BACKFILL

- A. Mixture shall be 4 parts topsoil (on-site or imported), 1 part peat moss, ½ part well-rotted manure and 10 pounds 5-0-5 planting fertilizer, mixed thoroughly per cubic yard.

### 2.2 TOPSOIL

- A. Source: Provide topsoil from existing stockpiles stripped from the project site and approved by the Engineer.
- B. Where existing topsoil is not available, provide topsoil conforming to the following:
  - 1. Original loam topsoil, well drained homogeneous texture and of uniform grade, without the admixture of subsoil material and entirely free of dense material, hardpan, sod, or any other objectionable foreign material.
  - 2. Containing not less than 5 percent nor more than 20 percent organic matter in that portion of a sample passing a 1/4-inch sieve when determined by the wet combustion method on a sample dried at 105 degrees C.
  - 3. Containing a pH value within the range of 6.5 to 7.5 on that portion of the sample that passes a 1/4-inch sieve.
  - 4. Containing the following gradations:

| SIEVE DESIGNATION | PERCENT PASSING |
|-------------------|-----------------|
| 1 inch            | 100             |
| 1/4 inch          | 97 - 100        |
| No. 200           | 20 - 60         |

## 2.3 SOIL AMENDMENTS

- A. Lime: ASTM C 602, Class T, agricultural limestone containing a minimum 85 percent calcium carbonate equivalent, with a minimum 90 percent passing a No. 10 mesh sieve and a minimum 50 percent passing a No. 100 mesh sieve.
  - 1. Provide lime in the form of dolomitic limestone.
  - 2. Add lime soil as necessary to achieve a soil pH between 5.5 – 7.0.
- B. Aluminum Sulfate: Commercial grade, unadulterated.
- C. Herbicides: EPA registered and approved, of type recommended by manufacturer.
- D. Sand: Clean, washed, natural or manufactured, free of toxic materials.
- E. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch sieve; soluble salt content of 5 to 10 decimeters/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
  - 1. Organic Matter Content: 50 to 60 percent of dry weight.

## 2.4 FERTILIZER

- A. Application of any fertilizer is prohibited between December 1st and April 1st and cannot be applied within 20' of a water body.
- B. Fertilizer: Mixed commercial fertilizers shall contain total nitrogen, available phosphoric acid and soluble potash in the ratio of 10-0-10. No fertilizer containing phosphorus is permitted on site.
- C. Other fertilizers meeting DOT Specification Section 713-03 Fertilizer can be used.

## 2.5 MULCH

- A. Dry Application, Straw: Stalks of oats, wheat, rye or other approved crops that are free of noxious weed seeds. Weight shall be based on a 15 percent moisture content.
- B. Hydro Application: Colored wood cellulose fiber product specifically designed for use as a hydro-mechanical applied mulch. Acceptable Product: Conwed Hydro Mulch, Conwed Fibers, 231 4th Street SW, Hickory, NC or approved equivalent.

## 2.6 SEED

- A. Furnish fresh, clean, new-crop seed mixed in the proportions specified for species and variety and conforming to Federal and State Standards.

- B. Acceptable material in a seed mixture other than pure live seed consists of nonviable seed, chaff, hulls, live seed of crop plants and inert matter. The percentage of weed seed shall not exceed 0.1 percent by weight.
- C. All seed will be rejected if the label or test analysis indicates any of the following contaminants: Timothy, Orchard Grass, Sheep Fescue, Meadow Fescue, Canada Blue Grass, Alta Fescue, Kentucky 31 Fescue, and Bent Grass.
- D. Provide seed mixture equal to Scotts Pure Premium Sun and Shade North Grass Seed Mixture, comprised of the following:
  - 1. Low maintenance Fescue Lawn grass seed mix
    - a. Seeding Rate: 6 lbs/1,000 square feet
    - b. Mix:

| AMOUNT BY WEIGHT IN MIXTURE | SPECIES OR VARIETY       |
|-----------------------------|--------------------------|
| 25 PERCENT                  | FIREFLY HARD FESCUE      |
| 25 PERCENT                  | BIG HORN GT HARD/SHEEP   |
| 20 PERCENT                  | INTRIGUE CHEWINGS FESCUE |
| 20 PERCENT                  | QUATRO SHEEP FESCUE      |
| 10 PERCENT                  | MINOTAUR HARD FESCUE     |

- 2. Wet-occasion wet locations
  - a. Seeding Rate: 4 lbs/1,000 square feet
  - b. Mix:

| AMOUNT BY WEIGHT IN MIXTURE | SPECIES OR VARIETY     |
|-----------------------------|------------------------|
| 20 PERCENT                  | RED TOP                |
| 20 PERCENT                  | ALKALI GRASS           |
| 10 PERCENT                  | AUTUMN BENTGRASS       |
| 20 PERCENT                  | VIRGINIA WILD RYEGRASS |
| 20 PERCENT                  | FOX SEDGE              |
| 10 PERCENT                  | FOWL BLUEGRASS         |

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas to receive landscaping for compliance with requirements and for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

#### 3.2 PLANTING SOIL PREPARATION



- A. Before mixing, clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful to plant growth.
- B. Mix soil amendments and fertilizers with topsoil as necessary to meet applicable ASTM standards.
- C. For lawns, mix planting soil either prior to planting or apply on surface of topsoil and mix thoroughly before planting.
  - 1. Mix lime with dry soil prior to mixing fertilizer. Prevent lime from contacting roots of acid-tolerant plants.

### 3.3 LAWN AREA PLANTING PREPARATION

- A. Limit sub-grade preparation to areas that will be planted in the immediate future.
- B. Loosen sub-grade to a minimum depth of 4 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous materials.
- C. Spread topsoil to depth (4 inches minimum) required to meet the thickness, grades, and elevations shown, after light rolling and natural settlement. Do not spread if planting soil or sub-grade is frozen.
  - 1. Place approximately 1/2 the thickness of planting soil mixture required. Work into top of loosened sub-grade to create a transition layer and then place remainder of planting soil mixture.
- D. Grade lawn and grass areas to a smooth, even surface with loose, uniformly fine texture. Roll (112-pound roller maximum) and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future. Remove trash, debris, stones larger than 1-1/2 inches in any dimension, and other objects that may interfere with planting or maintenance operations.
- E. Moisten prepared lawn and grass areas before planting when soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Restore prepared areas if eroded or otherwise disturbed after fine grading and before planting.

### 3.4 FERTILIZING

- A. The soil shall be tested for pH and lime added as necessary. All amendments shall be checked and approved by the Landscape Architect before amendments are made.
- B. Apply fertilizer at a rate of 20 LBS/1,000 SF.

### 3.5 SEEDING

- A. Assume all risks when seed is sowed before approval of seed analysis.
- B. Sow seed by hand broadcasting or hydroseeding. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in 2 directions at right angles to each other.
  - 1. Do not use wet seed or seed that is moldy or otherwise damaged in transit or storage.
  - 2. Do not sow immediately following rain, when ground is too dry, or during windy periods.
- C. Sow seed at the following rates:
  - 1. Low Maintenance Fescue Lawn, Seeding Rate: 6 lbs per 1000 sq. ft.
  - 2. Seed Mix for Wet Locations, Seeding Rate: 4 lbs per 1000 sq. ft.
- D. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray, immediately after each area has been mulched. Saturate to 4 inches of soil.
- E. Protect seeded areas with slopes less than 1:3 against erosion by spreading mulch after completion of seeding operations.
  - 1. Mulch rates.
    - a. Oat or wheat straw applied at a minimum rate of 2 tons per acre to form a continuous blanket 1-1/2 inches loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.
    - b. Fill tank with water and agitate while adding seeding materials. Use sufficient fertilizer, mulch, and seed to obtain the specified application rate. Add seed to the tank after the fertilizer and mulch have been added. Maintain constant agitation to keep contents in homogenous suspension. Prolonged delays in application or agitation that may be injurious to the seed will be the basis of rejection of material remaining in tank.
    - c. Apply slurry uniformly to all areas to be seeded in a one-step process. Apply mulch at a minimum rate of 57 gal/1000 sf (2500-lb/acre dry weight but not less than the rate required to obtain specified seed-sowing rate.
- F. Anchor mulch by spraying with asphalt-emulsion tackifier at the rate of 10 to 13 gal. per 1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

### 3.6 LAWN RESTORATION

- A. Renovate existing lawn within work limit.
- B. Renovate existing lawn damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.

- C. Reestablish lawn where settlement or washouts occur or where minor regrading is required.
  - 1. Install new planting soil as required.
- D. Remove lawn from diseased or unsatisfactory existing lawn areas; do not bury in soil.
- E. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
- F. Where substantial lawn remains, mow, dethatch, core aerate, and rake. Remove weeds before seeding.
- G. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- H. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and lawn, and legally dispose of them off Owner's property.
- I. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.
- J. Apply soil amendments and fertilizers required for establishing new lawn and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.
- K. Apply seed and protect with straw mulch as required for new lawn.
- L. Provide lawn maintenance as required for new lawn.

### 3.7 SATISFACTORY LAWNS, GRASS, AND LAWN RESTORATION

- A. Satisfactory Lawns, Grass, and Lawn Restoration: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 95 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
- B. Reestablish those that do not comply with requirements and continue maintenance until satisfactory.

### 3.8 CLEANUP AND PROTECTION

- A. During landscaping, keep pavements clean and work area in an orderly condition.
- B. Protect landscaping from damage due to landscape operations, operations by other contractors and trades, and trespassers. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged landscape work as directed.

3.9 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of it off the Owner's property.

END OF SECTION

## SECTION 334100 - STORM UTILITY DRAINAGE PIPING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Under this section the Contractor shall provide all labor, equipment and material necessary to furnish, install and test all storm utility drainage pipe and fittings as shown on the Contract Drawings.

#### 1.2 RELATED WORK SPECIFIED ELSEWHERE

- A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
  - 1. Section 31 20 00: Excavation and Fill
  - 2. Section 33 49 00: Storm Drainage Structures

#### 1.3 PROJECT CONDITIONS

- A. Location of Sewers and Sewer Structures: The location, elevation, and grades of sewers and sewer structures are shown on the Contract Drawings and shall be adhered to as closely as possible. If during construction of the project, it becomes necessary to make changes in the location or grades of the sewers, the Engineer will issue appropriate directions after being contacted by the Contractor.
- B. Site Information: Perform site survey, research public utility records, and verify existing utility locations. Verify that storm sewerage system piping may be installed in compliance with original design and referenced standards.

#### 1.4 SUBMITTALS

- A. Shop Drawing: Pipes and associated fittings.
- B. Product Data: Manufacturer's specifications, including dimensions, allowable height of cover information, and installation instructions.
- C. Manufacturer's product literature, installation instructions and shop drawings for infiltration systems.
- D. As-built record drawings at project closeout of installed storm sewerage piping and products. An as-built survey prepared by licensed NYS Surveyor depicting the installed storm sewer piping and structures including rim and invert elevations of structures pipe size, pipe type, and invert of all piping. Both hard copy and electronic copy shall be provided to the Owner and Engineer.

## 1.5 QUALITY ASSURANCE

- A. Comply with standards of the Chain Link Fence Manufacturer's Institute.
- B. Provide steel fence and related gates as a complete compatible system including necessary erection accessories, fittings, and fastenings.
- C. Posts and rails shall be continuous without splices.

## 1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of the General Conditions.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

## 1.7 SEQUENCING AND SCHEDULING

- A. Coordinate with other utility work.

# PART 2 PRODUCTS

## 2.1 MATERIALS

- A. Corrugated Polyethylene Pipe (HDPE, Dual Wall with Smooth Interior): Conform to AASHTO M-294.
  - 1. Classification: Soil-tight, integral bell and spigot joints. Joints shall be sealed with factory installed rubber O-ring gaskets that meet ASTM F-477.
  - 2. Coefficient of Roughness (interior pipe surface): 0.012 maximum (Manning formula).
  - 3. Joint Couplings (Soil-tight): Polyethylene, bell-and-spigot type couplers utilizing an elastomeric gasket conforming to ASTM F-477.
  - 4. Fittings:
    - a. High density polyethylene meeting the properties specified for the pipe.
    - b. Either molded or fabricated.
    - c. Designed specifically for the pipe furnished and manufactured by the pipe manufacturer.
  - 5. Acceptable Manufacturer:
    - a. AdvanEdge oblong corrugated pipe by Advanced Drainage Systems, Inc., (ADS) 3300 Riverside Dr., Columbus, OH 43221; (614) 457-3051

- b. ProLink ST (N-12 IB ST), Smooth Interior Pipe & Fittings by Advanced Drainage Systems, Inc., (ADS) 3300 Riverside Dr., Columbus, OH 43221; (614) 457-3051
  - c. Approved equivalent.
- B. High Density Polyethylene Pipe (HDPE) Perforated Pipe: Perforated double wall smooth interior pipe complying with the following:
  - a. 4" to 10" diameter pipe to conform to AASHTO M 252.
  - 2. 12" to 36" diameter pipe to conform to AASHTO M 294
  - 3. Coefficient of Roughness (Interior Pipe Surface): 0.012 maximum (Manning Formula).
  - 4. Classification: Type S
  - 5. Joint Couplings: Polyethylene, bell and spigot type couplers utilizing an elastometric gasket conforming to ASTM F 477. Snap on type or split collar through 24" diameter.
  - 6. Corrugated to match pipe corrugations, width not less than one half the pipe diameter.
  - 7. Split couplings shall engage an equal number of corrugations on each side of the joint.
  - 8. Fittings: Either molded or fabricated, high density polyethylene components meeting the properties specified for, and designed specifically for the pipe manufactured by the pipe manufacturer.
  - 9. Perforated Pipe: Conform to AASHTO M-252 or AASHTO M-294, Type SP with Class I perforations.
  - 10. Specifications have been based on products manufactured by Advanced Drainage Systems, Inc, Columbus, Ohio (Tel. #614-457-3051) or Hancor, Inc., Findlay, Ohio (Tel. #800-847-5880).
- C. Polyvinyl Chloride (PVC) Pipe for in-line drain piping, solid: Conform to ASTM D-3034 and ASTM F1336 (SDR-35)
  - 1. Conform to shape, dimensions, and thickness shown on the Contract Drawings.
  - 2. Provide fittings of the same size and pressure rating as the pipe to which they are connected.
  - 3. Rubber gasketed joints manufactured in accordance with ASTM D-3139.
  - 4. Rubber gaskets shall comply with ASTM D3212 Internal Pressure Test and Vacuum Test at 5 degrees of gasket joint deflection.
  - 5. AdvanEdge Pipe and Couplings, as manufactured by Advanced Drainage Systems, Inc., (ADS) 3300 Riverside Dr., Columbus, OH 43221; (614) 457-3051, or approved equivalent.
- D. Synthetic Flat Panel Underdrain System Piping
  - 1. Flat panel underdrain system complying with the following:
  - 2. 1-1/2" X 12" oblong corrugated pipe flat panel underdrain, model #12000, wrapped in geotextile fabric meeting ASTM D7001.

3. Pipe shall have annular interior and exterior corrugations.
4. Pipe shall have internal bracing adjoining each long wall.
5. End connectors fabricated for use with 5" solid HDPE riser pipe.
6. Solid HDPE collector pipe.
7. Materials manufactured by Multi-Flow Drainage Systems or approved equal.
8. Fittings: Either molded or fabricated, high density polyethylene components meeting the properties specified and designed specifically for and by the same manufacturer as the flat panel underdrain system.
  - a. 45° Wye (Horizontal)
  - b. End Outlet
  - c. End Cap
  - d. Split Coupling
  - e. Fittings shall be by ADS AdvanEDGE or approved equivalent.

## 2.2 GEOTECHNICAL FABRIC

- A. Filter Fabric (GeoTextile):
  1. Separation for Underdrains: Amoco 2002 & 2004, Contech Construction Products Inc. C-180, Synthetic Industries Geotex 250ST & 315ST, Mirafi Geolon HP570 & HP1500 or approved equivalent.

## PART 3 EXECUTION

### 3.1 MAINTENANCE OF EXISTING STORMWATER FLOWS

- A. Provide all temporary facilities required to safely and adequately bypass existing stormwater flows from the Work area during construction.
- B. The bypassing of such flows shall prevent any hazards to public health and welfare when the stormwater flows are bypassed from the Work area during construction.
- C. The Contractor is fully responsible for any and all damages to construction, adjacent properties, utilities, and/or buildings in the area caused by these operations.

### 3.2 INSPECTION

- A. Inspect pipe and fittings before installation. Remove defective materials from the Site.
- B. Concrete pipes shall be free from fractures, cracks, and surface roughness.
- C. Pipe with damaged ends will not be accepted when such damage would prevent making a satisfactory joint.

### 3.3 INSTALLATION



- A. General Locations and Arrangements: Contract Drawings (plans and details) indicate the general location and arrangement of the underground storm sewerage system piping. Location and arrangements of piping layout take into account many design considerations. Install the piping as indicated, to the extent practical. If, during construction of the project, it becomes necessary to make changes in the location or grades of the sewers, the Engineer will issue appropriate directions after being contacted by the Contractor.
- B. Install piping beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings in accordance with manufacturer's recommendations for use of lubricants, cements, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.
- C. Use manholes or catch basins for changes in direction, except where a fitting is indicated. Use fittings for branch connections, except where direct tap into existing sewer is indicated.
- D. Use proper size increasers, reducers, and couplings, where different size or material of pipes and fittings are connected. Reduction of the size of piping in the direction of flow is prohibited.
- E. Install piping pitched down in direction of flow, at minimum slope of 1 percent, except where indicated otherwise.
- F. Extend storm sewerage system piping to connect to building storm drains, of sizes and in locations indicated.
- G. Fill excess excavation with suitable materials and tamp.

### 3.4 STORM SEWER RELATION TO WATER LINE

- A. Horizontal Separation: Storm sewers should be laid at least 10 feet, horizontally, from any existing or proposed water line.
- B. Vertical Separation: Whenever sewers must cross water line, the storm sewer shall be laid at such so there is an 18-inch vertical separation between the two lines. When the elevation of the sewer cannot be varied to meet the above requirements, the water main shall be relocated to provide this separation or reconstructed with push-on joint pipe for a distance of 10 feet on each side of the sewer. One full length of water main should be centered over the sewer so that both joints will be as far from the sewer as possible.

- C. Special Conditions: When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the water main should be constructed of a slip-on or mechanical-joint ductile iron pipe, and the sewer constructed of mechanical-joint ductile iron pipe and both pressure tested to assure water tightness.

### 3.5 PROTECTING PIPE

- A. During the progress of the Work keep pipe clean from all sediment, debris, and other foreign material.
- B. Close all open ends of pipes and fittings securely with removable plugs at end of Work day, during storms, when the Work is left at any time, and at such times as Engineer may direct.

### 3.6 TAP CONNECTIONS

- A. Make connections to existing piping and underground structures so that finished work will conform as nearly as practicable to the requirements specified for new work.
- B. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap, with not less than 6 inches of 3000-psi 28-day compressive-strength concrete.
- C. Make branch connections from side into existing 4- to 21-inch piping by removing section of existing pipe and installing wye fitting, into existing piping. Encase entire wye with not less than 6 inches of 3000-psi 28-day compressive-strength concrete or,
- D. Make branch connections from side into existing 24-inch or larger piping or to underground structures by cutting opening into existing unit sufficiently large to allow 3 inches of concrete to be packed around entering connection. Cut end of connection pipe passing through pipe or structure wall to conform to shape of and be flush with inside wall, unless otherwise indicated. On outside of pipe or structure wall, encase entering connection in 6 inches of concrete for minimum length of 12 inches to provide additional support of collar from connection to undisturbed ground.
  - 1. Provide concrete that will attain minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.
  - 2. Use epoxy bonding compound as interface between new and existing concrete and piping materials.
    - a. Protect existing piping and structures to prevent concrete or debris from entering while making tap connections. Remove debris, concrete, or other extraneous material that may accumulate.

### 3.7 FIELD QUALITY CONTROL

- A. Cleaning: Clear interior of piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.
  - 1. In large, accessible piping, brushes and brooms may be used for cleaning.
  - 2. Place plugs in ends of uncompleted pipe at end of day or whenever work stops.
  - 3. Flush piping between manholes, if required by local authority, to remove collected debris.
- B. Interior Inspection: Inspect piping to determine whether line displacement or other damage has occurred.
  - 1. Make inspections of pipe between manholes/fittings, after pipe has been installed and approximately 2 feet of backfill is in place, and again at completion of project.
  - 2. If inspection indicates poor alignment, debris, displaced pipe, infiltration, or other defects, correct such defects and re-inspect.
- C. Water Tightness of Sewer Structures: It is the intent of the Contract Drawings and these Specifications that the completed storm sewer lines shall be as watertight and free from infiltration as practical, unless specified otherwise. All visible leaks or points of infiltration shall be repaired.

END OF SECTION